

Draft Feasibility Report and Environmental Assessment

Roseau, Minnesota

Flood Damage Reduction Project Roseau River

St. Paul District, Corps of Engineers
Feasibility Study

June 2006

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DETAILED TECHNICAL DOCUMENTATIONS ARE INCLUDED AS PART OF THIS FEASIBILITY STUDY REPORT. HOWEVER, NOT ALL SUPPORTING DOCUMENTATION HAS BEEN INCLUDED IN THIS REPORT. IF SPECIFIC ADDITIONAL TECHNICAL BACKGROUND OR EVALUATION DATA PERTINENT TO THIS PROJECT IS DESIRED, THIS INFORMATION MAY BE AVAILABLE UPON REQUEST.

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Executive Summary

Roseau is in Roseau County in the northwestern corner of Minnesota, approximately 10 miles south of the Canadian border and 65 miles east of the North Dakota border. The Roseau River flows north through the city. The city and the areas immediately adjacent to the east form the project area. The population of Roseau is approximately 2,800. Polaris Industries, Inc., employs over 2,100 people and, along with agriculture, provides a solid economic base for the community. Roseau County has 16,000 residents; the population is expected to increase to 19,000 by 2030.

Because of the relatively low elevation and flat topography, the majority of the city is located in the regulatory floodplain. As a result, when the river flows out of its banks, it inundates most of the city. From June 9-11, 2002, intense rainfall over the river basin dumped an extraordinary amount of water into the area. This water quickly collected and drained into the Roseau River, overtopping the city's emergency levee system and flooding most of the developed area. The downtown businesses and private residences suffered devastating damage. More than 50 homes, many owned by low-income families, had to be demolished and replaced. The total estimated damages exceeded \$120 million.

The St. Paul District, Corps of Engineers, completed a Section 905(b) analysis for the Roseau River subbasin in August 2003. That approved report identified a number of possible flood reduction plans and features that had a strong potential to become a Federal project. Based on recommendations in the Section 905(b) analysis, the city of Roseau and the Federal Government entered into a feasibility cost share agreement and started feasibility studies in September 2003 (Note: the non-Federal sponsor and Federal Government each pay 50 percent of the feasibility study cost). Since then, considerable data have been collected and analyzed. A preliminary evaluation of possible alternative flood damage reduction plans for Roseau and the surrounding study area was documented in the April 2005 letter report.

The feasibility study initially collected pertinent engineering, economic, and environmental data. Interagency, public and potentially affected landowner concerns were identified, and potential issues and opportunities were defined to conduct a comprehensive screening of alternative plans. Following the screening, a single plan was identified for detailed design and evaluation. The design for that plan was optimized, alignments and features were refined, a baseline cost estimate was completed, and the resulting plan was fully documented from an economic and environmental perspective. The optimized plan, referred to as the National Economic Development (NED) plan, defines a multifeatured project that would provide reliable permanent flood damage reduction for Roseau and integrate needed public recreational facilities.

This optimized plan consists of a 150-foot-wide east side diversion channel, three bridges, and a restriction bridge. This plan would remove nearly the entire city from the 100-year regulatory floodplain and would decrease stages upstream of Roseau to Malung,

Minnesota. The NED plan would reduce future flood damages by nearly 86 percent and provide a solid physical foundation for flood fighting for all floods that would exceed the project design capacity.

In addition to the NED plan, the non-Federal sponsor has requested that two storage areas be added to the NED plan. These storage areas would be used to decrease any downstream stage increases that would result from the NED plan. Because of the infrequency and small (0.1-foot) increase in stage, the storage areas could not be justified as part of the NED plan. These features have been included in the recommended Locally Preferred Plan (LPP), and all incremental project costs due to these changes will be the responsibility of the non-Federal sponsor.

Implementing the recommended plan would result in a substantial beneficial effect on the local economy by allowing for future growth and improved public safety and peace of mind and removing large urban areas from the regulatory floodplain. It is important to note that the recommended optimized plan fits into regional flood storage plans that could ultimately further reduce flooding risks to the project area. In addition to flood damage reduction, the proposed plan contains a number of recreational trails and plantings that would benefit the city and the region.

The total cost of the recommended multifeatured LPP is approximately \$24.4 million. The Federal share of the NED project would be \$13.3 million; the non-Federal share would be \$8.1 million and an additional \$2.9 million for the LPP plan based upon the general cost allocations established by the Water Resources Development Act (WRDA) of 1986, as amended. The benefit-cost ratio for the LPP plan has been calculated at approximately 1.6 for the flood damage reduction portion of the project and 18.8 for the recreation portion. The overall project benefit-cost ratio is estimated at 2.9. Therefore, the project would be economically feasible.

Estimated Implementation Costs: (October 2005 price level)

Federal	Cost-Sharing
Corps of Engineers – flood damage reduction (65 percent)*	\$ 12,554,100
Corps of Engineers – recreation (50 percent)	\$ <u>830,500</u>
Corps of Engineers – total	\$ 13,384,600
Non-Federal (NED)	
City of Roseau – flood damage reduction (35 percent)*	\$ 7,340,900
City of Roseau – recreation (50 percent)	\$ <u>830,500</u>
City of Roseau NED – total	\$ 8,171,400
Locally Preferred Plan (LPP) Increment	\$ <u>2,861,000</u>
City of Roseau Project Total	\$ 11,032,400
Total Project	\$ 24,417,000

5 1/8-percent Interest rate over a 50-year evaluation period

* The local share is higher than 35 percent because of the land, easement, right-of-way, relocation, and disposal area (LERRDs) costs of this project.

Roseau has committed itself to serve as the non-Federal sponsor for the project; the State of Minnesota has indicated it would provide most of the local funding. The Roseau River Watershed District also supports the proposed project. Based on the non-Federal sponsor and public support for the Federal flood damage reduction recommended plan, it appears support for the recommended plan is very strong. However, the extent and nature of public and interagency concerns associated with the project will be more fully assessed as part of the report review process and will be documented in the final report. Continued efforts to minimize and/or avoid landowner and environmental impacts will continue during the refinements made to the plan during the plans and specifications phase.

Study Authority

The Roseau River subbasin is a part of the Red River of the North basin. The Red River Reconnaissance Study was authorized by a 30 September 1974 resolution of the Senate Committee on Public Works:

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review reports on the Red River of the North Drainage Basin, Minnesota, South Dakota and North Dakota, submitted in House Document Numbered 185, 81st Congress, 1st Session, and prior reports, with a view to determining if the recommendations contained therein should be modified at this time, with particular reference to flood control, water supply, waste water management and allied purposes.

The fiscal year (FY) 2001 Energy and Water Development Appropriations Act (Public Law 106-377) provided funds to conduct the Section 905(b) (WRDA 1986) analysis.

Additional funding to prepare and evaluate the Federal interest specific to a potential Roseau River flood damage reduction project was provided through the Continuing Authorities Program (CAP) in FY 2002 and FY 2003. These funds were used to conduct the June 2003 Section 205 Federal interest study (FIS) for Roseau and adjacent lands, consistent with Section 205 of the 1948 Flood Control Act.

Based on recommendations contained in the section 905(b) analysis, the city of Roseau and the Federal Government entered into a feasibility cost share agreement. The feasibility study was initiated in September 2003 (Note: the non-Federal sponsor and Federal Government each pay 50 percent of the feasibility study cost).

The Federal Water Project Recreation Act of 1965 (Public Law 89-72), as amended, requires an agency to fully consider recreational features that may be associated with Federal flood damage reduction projects.

Report Purpose and Scope

The St. Paul District has completed this feasibility report and associated environmental assessment as a formal decision document. This report documents plan formulation studies conducted by the St. Paul District in close cooperation with the city of Roseau, the Roseau River Watershed District, and the State of Minnesota.

The purpose of this report has been to collect and evaluate pertinent engineering, economic, social, and environmental information about current conditions in the study area to define a feasible and implementable Federal flood damage reduction project that would provide permanent flood protection for Roseau. To accomplish this purpose, an array of possible flood damage reduction plans was considered and screened to define alternative remedial actions for possible implementation in the study area.

Study Area

The “study/project area” for this feasibility report focuses on the city of Roseau and the surrounding area (see project location in figure 1). The Roseau River cuts the city in two, and then flows north toward Canada. Roseau is located 10 miles south of Canada and 65 miles east of North Dakota. The Roseau area economy depends on Polaris Industries, Inc. (employing over 2,100), and the agricultural opportunities present in the Red River Valley.

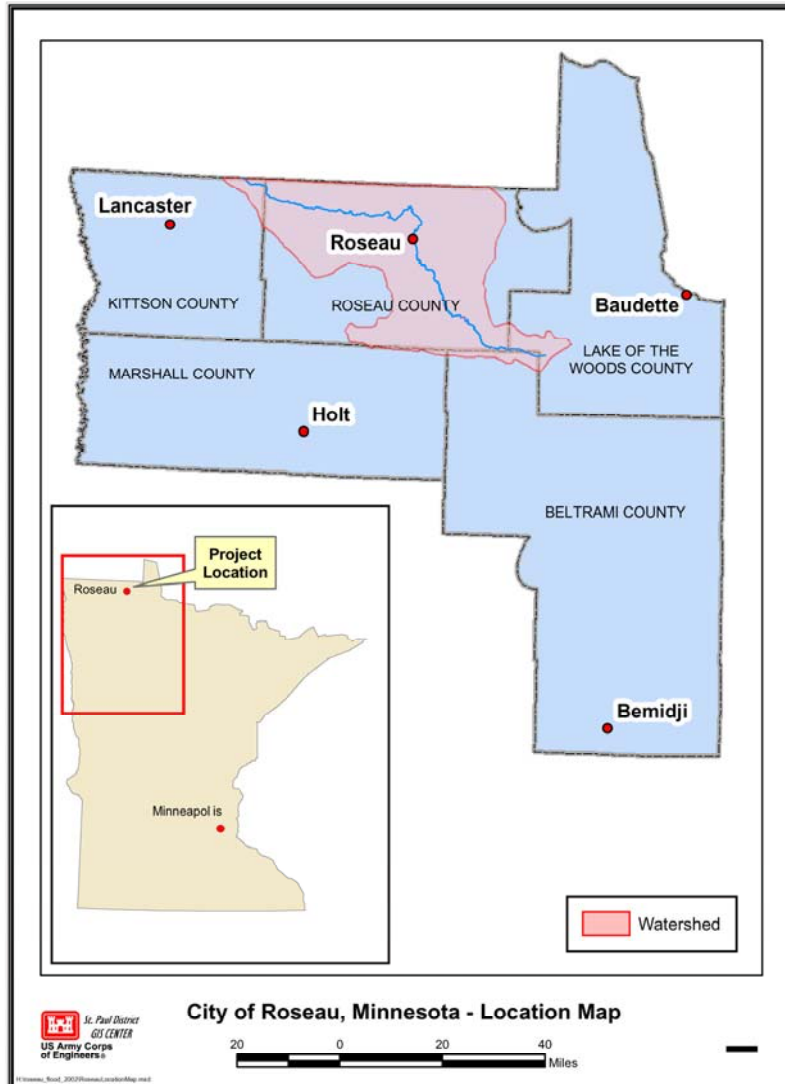


Figure 1. Roseau Project Location Map

Summary Description of Flooding History

Throughout the community's early history, floods were simply endured, with little organized effort made to combat the waters of the Roseau River. Floodwaters frequently inundate large areas of the Red River Valley during the spring snowmelt, and the Roseau River is particularly susceptible following heavy summer rains. As a result, private residences, businesses, and public resources are subject to heavy damage. Over time, as the areas along the rivers have become more developed, significant amounts of money have been spent on temporary flood protection, and, when floods occur, on flood damage repair and cleanup.

Roseau lies in the dry lakebed of Glacial Lake Agassiz. The region is very flat, which results in floodwaters covering thousands of acres of land once the riverbanks are overtopped. The extreme sensitivity of the area means that mere inches can be the difference between being dry or wet. Roseau has experienced many floods, the most notable in 2002 when virtually the entire city was affected. Other major floods occurred in 1896, 1916, 1938, 1942, 1947, 1950, 1966, 1979, 1985, 1996, 1997, 2004, and 2006. As can be seen by historical dates, flooding in Roseau is not a one-time problem but a consistent problem that has occurred regularly over time.

Prior Studies, Reports, and Projects

The Corps of Engineers and other regional, State, and local entities have conducted numerous studies relevant to this planning report, including studies in the Roseau area and studies that have been done on the Red River and its tributaries. Following is a brief list of the literature most relevant to this study:

- *Alternatives Screening Report, Letter Report - Roseau, Minnesota, Flood Control Feasibility Study, April 2005.* Indicated which alternatives made it to the final screening and presented the selected alternative, which was the east diversion.
- *Section 905(b) Analysis Roseau River Subbasin – Roseau, Minnesota, Local Flood Protection, August 2003.* Determined that sufficient indications of a cost-effective engineering solution to the flood problems in Roseau existed and recommended the start of the feasibility study.
- *Phase I Environmental Site Assessment Report, Roseau River Diversion Feasibility Study Area, Roseau, Minnesota, May 2005.* Determined that further assessments would be needed for the in-town levee alternatives, with minimal assessments needed for the east diversion plan.

- *Section 22 Study, City of Roseau and Upstream Reaches on the Roseau River, Roseau County Minnesota, December 2004.*
- *Section 205, Federal Interest Milestone Report, Initial Appraisal Report, Corps of Engineers, June 2003.*
- *Hay Creek Section 206 – Ecosystem Restoration Report/Environmental Assessment, November 2003.*
- *West Interceptor - Roseau County. In progress.*
- *Section 905(b) (WRDA 1986) Analysis, Red River Basin; Minnesota, North Dakota, South Dakota, September 2001.*
- *Red River Basin Board Inventory Process, Final Reports, 2000.*
- *Red River Valley Water Supply Study, Phase II Report, Bureau of Reclamation, 1998.*
- *Red River Basin Flood Damage Reduction Work Group Agreement, 1998.*
- *The Next Flood: Getting Prepared, Final Report of the International Red River Basin Task Force, 2000.*
- *Final Report of the International Flood Mitigation Initiative for the Red River Basin, December 2000.*
- *Environmental Impact Study of Flood Control Impoundments in Northwestern Minnesota, July 1996.*
- *Water Resources Engineering/Planning Program for the Red River of the North Basin in Minnesota, 1984.*
- *Souris-Red-Rainy River Basins Comprehensive Study, 1972.*
- *Red River of the North Reconnaissance Report, December 1980.*
- *Flood Insurance Studies, Federal Emergency Management Agency.*



Aerial views of the community during the 2002 flood reveal the extent of flooding.



Downtown Roseau was flooded in 2002, and the flood served as a wake up call for the city; all levels of government now recognize the need for permanent flood damage reduction.



Piles of debris lined the streets following the 2002 flood.



Flooding is a recurring problem in Roseau as can be seen by the construction of this temporary levee in 2004.



Although not as devastating, the 2004 flood served as a reminder that something needed to be done to permanently protect the city.

Overview of Project Plan Formulation

National and Local Planning Goals

National planning goals and procedures are administered consistently throughout the country. Principles were established by public law, and guidance is defined in specific Corps-wide planning regulations known as the "Planning Guidance Notebook" (Engineering Regulation 1105-2-100).

Local design procedures and criteria were also provided to the Corps design team for integration into the project design. Local standards for road design and public utility designs were integrated into the project designs.

The study team tried to take advantage of any secondary opportunities that a flood damage reduction project might offer (for example, recreation and associated incidental benefits such as ecosystem restoration and aesthetic development).

To be an implementable federal project, the project must have the support of the non-Federal sponsor(s) and a demonstrated Federal interest in implementing the plan. To obtain Federal funding for a flood damage reduction project, the plan formulation process must adhere to laws, policies, and regulations that define the planning and design process to be followed and establish specific design criteria and requirements. These criteria and requirements establish consistent standards for project designs and implementation/construction and assure that the project features will perform reliably.

General Planning Process Used

To effectively formulate a feasible flood damage reduction project and assess its effects, a full array of potential flood damage reduction strategies and associated specific plans must be considered. Plan comparison evaluations are done initially at a low level of detail through an FIS or reconnaissance study. These initial efforts focus on determining if it is likely that a feasible plan in the Federal and local interest exists. If Federal and local interest is found, studies in a greater level of detail are completed during the feasibility study. Flood damage reduction plans found to be economically feasible, environmentally feasible, and socially acceptable are evaluated further in a progressive screening process until a single NED plan can be defined and documented. This NED plan is the plan that has the greatest net benefits and is the plan that the Federal Government is most supportive of constructing. One exception to this process is when the non-Federal sponsors identify an LPP. An LPP is an economically feasible plan that is selected by the non-Federal Sponsor. If it is more expensive than the NED plan, it may require higher non-Federal cost sharing to implement. The non-Federal sponsor may also request betterments that may be integrated into the project construction once a Federal project is justified. These betterments can include

construction features that provide greater capacity or are of a higher than required quality. Betterments are designed and constructed with 100 percent non-Federal funding.

Public and interagency involvement, scoping, and product reviews are sought throughout the process to keep the public informed and to receive and incorporate pertinent ideas and concerns. Potentially-affected landowners and other stakeholders are also involved in the plan formulation process to try to find a project design that reasonably minimizes project related impact and can be supported from a general public perspective.

Existing Conditions

The city of Roseau is located in rural northern Minnesota. The city continues to go against national trends and is a thriving small town growing 15 percent between 1990 and 2000. This growth is supported by the city's heavy reliance on manufacturing and agriculture in the region. The impacts of agriculture are visible in the Roseau areas as land use in the region has changed from 52 percent wetlands and 31 percent forest to its present condition of 6 percent forest, 43 percent wetland, and 40 percent cultivated land.

The area immediately outside of Roseau consists mainly of farmed lands, with the occasional small pockets of woodlands and wetlands providing minimal habitat value. The land use in the region makes the diverse population of wildlife surprising. This diversity is primarily the result of the presence of publicly-owned natural resource areas scattered along the fringes of the watershed. A number of small parks and recreational facilities are aimed toward team sports in the city. However, the area is lacking passive and family-orientated recreational resources such as walking and biking trails.

The Roseau area is very flat, and once waters exceed the banks of the Roseau River flooding can span out for miles. In the river's immediate path is the city of Roseau, which can quickly be inundated because of the flashiness of the river. The river is prone to flooding during the spring, when snow melts, and in the summer following rainfall events. Over the past 10 years, the city of Roseau has fought eight major floods, most recently in 2006. The city currently relies on a series of temporary emergency levees and heroic responses, which, in the past, have been too slow due to the flashiness of the river.

Future without Project Conditions

Definition

If no flood damage reduction measures are implemented, flooding and damage to large portions of the city of Roseau and surrounding areas will continue to occur. As the area continues to grow and develop, emergency service costs will increase along with the potential damage from spring and rainfall caused floods. The city will continue to rely on heroic responses and poorly maintained temporary emergency levees as the primary line of defense against future flood events.

At some point, catastrophic flood damages will occur in Roseau (similar to the 2002 Roseau River flood). When that future event occurs, the potential for loss of life exists and the probability is high that many structures will be significantly damaged. This event will result in high public costs as part of the emergency response and buyouts. Another catastrophic flood in Roseau would be a local nightmare that would devastate the community, fiscally and socially.

The future without project condition was based on the following assumptions:

1. The city of Roseau will continue to belong to the National Flood Insurance Program and will follow all rules and regulations associated with being in that program.
2. Future flood damages will remain unchanged. The assumption is that the damages eliminated through structure buyouts would be offset by damages to new development.
3. The existing emergency levee system was analyzed and credit was given in certain reaches to varying elevations; these levees will remain in that condition for the future. See geotechnical appendix (Appendix G) for more information.
4. The city of Roseau and the Roseau River Watershed District are pursuing significant internal drainage projects: (a.) and (b) will be completed prior to the completion of the recommended plan.
 - a. West Intercept Project. This project will divert overland flows coming from the west of the city to the north to the old Roseau Lake bottom.
 - b. West side storm water system. This system will divert storm water into a large storm water basin, with a pump station being used for continuous operation. This project is under construction.

c. East side storm water protection will connect the three main storm sewer outlets and will eventually direct flows into a storage area north of town. Currently, the storm outlets are pumped with portable pumps. The current use of pumps is sufficient during floods.

5. Other planned or proposed regional projects would not significantly alter the current flooding problem in the area.

Specific Objectives, Opportunities, and Concerns

At strategic points in plan formulation, important briefings and/or conferences were held with participation from the District design team, non-Federal sponsors, and interested State and Federal agency representatives. These communications and conferences were intended to insure that policy issues and critical formulation decisions about the project would be fully understood by all shareholders, adjustments to plans would be made wherever practical, and the project formulation would be informally confirmed before moving into the next phase of the project formulation and/or design. In this way, the study objectives, opportunities, and concerns have been identified, and a number of design improvements have been incorporated into the recommended plan.

The water resource related problems and opportunities associated with the larger context basin-wide and subbasin area were presented in the August 2003 Section 905(b) analysis for the Roseau River subbasin (see that report for detailed basin-wide perspectives of problems and opportunities). The project delivery team made efforts to collect and summarize basin-wide problems and opportunities through reconnaissance phase coordination with stakeholder and interagency groups. In addition, discussions with the public, city, State, watershed, and county officials have identified specific localized objectives, concerns, problems, and opportunities for incorporation into the Roseau project formulations. These concerns/problems were first identified in the Section 905(b) report and revised throughout the planning process. The revised problems, opportunity, and planning constraints are shown below.

PRIMARY PROBLEM – The city of Roseau is vulnerable to flooding from both spring snowmelt and rainfall events, and additional flood protection is needed to permanently protect the city from these frequent events.

As an example, on June 9-11, 2002, intense rain fell over the Roseau River basin, dumping an extraordinary amount of water into the study area (as much as 14 inches of rain fell in some locations). This water quickly collected and drained into the Roseau River, overflowing the city's emergency levee system and flooding most of the area. All the structures in town with the exception of the high school and several manufacturing buildings were flooded. The flood damages were devastating, with significant damage to downtown businesses and private residences. City services were affected significantly for months. An estimated \$50 million in damages to city public and hospital buildings, streets, and public utilities occurred. More than 50 homes, many owned by low-income families, had to be demolished. The Roseau County Museum, Interpretive Center, City Hall, and Library also

needed to be demolished. This major flood lasted for several weeks, with heavy impacts on more than 80 percent of the city. Total damages for this single event have been estimated at more than \$120 million and have resulted in major hardships to the entire city.

PROBLEM – The city of Roseau relies heavily on temporary emergency levees, which are in poor condition, leaving the city vulnerable to levee failures and catastrophic flooding.

After the temporary levee systems in Roseau were overtopped during the 2002 flood, local concern grew about reliance on the city's temporary levee systems for permanent protection. Strong local support was shown for alternative solutions that would minimize further social impacts from flooding and permanent solutions (for example, local residents fear that permanent setback levees would significantly affect the community and would also make the existing housing shortage more acute). As a result of these concerns, the Corps analyzed several possible diversion plans that would reduce or eliminate reliance on temporary levees in the city.

PRIMARY OBJECTIVE – To define an implementable permanent flood damage reduction project that would significantly reduce the long-term risk of catastrophic flood damages to Roseau. Such a project needs to be technically feasible from engineering and economic perspectives. The NED plan may not be implementable because of its downstream effects; however, the recommended LPP plan would be implementable.

OBJECTIVE – An important study objective is that the recommended flood damage reduction plans need to fit into long-term regional flood damage reduction goals (long term a number of local and State sponsored plans are being pursued to reduce flooding throughout the Roseau River subbasin).

The recommended plan fits with the regional flood damage reduction plans and could be complemented by the implementation of those plans. The local watershed district and city are pursuing plans to assist with drainage issues in the basin.

PLANNING CONSTRAINT – A key objective for the non-Federal sponsor is that the project would not induce damages to areas upstream or downstream of the study area and that damage to the “opposite side of the river” from any proposed project features would not occur or is minimized.

In response to this constraint, hydraulic project design criteria were established to avoid flood damage reduction actions that would induce higher stages upstream or downstream. This design has been incorporated into the recommended LPP plan by the addition of storage areas to the NED plan.

PLANNING CONSTRAINT – Poor riverbank and levee foundation stability are problems in the project area.

From an engineering perspective, the major geotechnical constraint is the potential for poor riverbank and levee foundation stability. The instability is caused by a combination of

geologic and geomorphologic conditions in the area. A typical location where stability is of greatest concern is on the outside of a meander in the river, where erosion forces are highest. The erosional nature of the river, combined with the weak lacustrine soils deposited in the geologic past, contributes to the riverbank and levee foundation stability problems throughout the study area. Levees located near or on the outside of meanders would need to be set back from the riverbank, resulting in removal of houses and other related structures, resulting in social impacts.

PLANNING CONSTRAINT – An environmental issue that could affect project design is the potential presence of hazardous, toxic, or radioactive waste (HTRW) materials.

To assess the study area for potential HTRW materials and for other contaminated materials that may not meet the strict definition of HTRW materials (as defined in ER 1165-2-132), an environmental site history, phase I environmental site assessment and phase I field investigation were completed for the study area in May 2005. The investigations indicated that, if the diversion plan were selected, no further investigation was recommended.

CONCERN – The project area could potentially have historically or culturally significant sites, which are common near riverbanks in the region.

Construction of a flood damage reduction project could affect historically/culturally significant sites in the current project alignment. The extent of the impacts is not yet fully defined; the planning and design phases will evaluate such effects and seek to avoid or minimize any damages to such sites. A detailed cultural analysis will be completed in the plans and specifications phase. This inventory and evaluation will be accomplished very early in the planning, engineering, and design phase of implementation and will continue to be fully coordinated with the State Historic Preservation Officer (SHPO). If significant sites are identified, the final designs would be refined to avoid, minimize, or, if unavoidable, mitigate project related impacts. Preliminary evaluations and coordination with the SHPO show that the likelihood of cultural or historic sites along the project alignments is minimal.

CONCERN– Federally designated threatened species may have habitat in the project area.

Three federally designated threatened species (bald eagle, Canada lynx, and gray wolf) are listed as being present in Roseau County. These species and their critical habitat needs will be carefully considered in the alternative selection and design phases to avoid and/or minimize impacts on these species. It has been determined that the proposed east diversion (NED plan) would not contain critical habitat for the three threatened species. See the environmental assessment (Appendix E) for more information.

CONCERN - Fish passage in the river is an important issue for many agencies involved in the coordination of this plan.

The U.S. Fish and Wildlife Service (USFWS), the Minnesota Department of Natural Resources (MnDNR), the Corps of Engineers, and other management agencies have made considerable efforts to restore or maintain fish passage on the Red River and its tributaries.

Care to prevent blocking fish passage on the Roseau River is a formulation constraint and was considered in developing the NED plan. A pilot channel in the diversion channel was analyzed and considered for fish passage; it was determined that this feature would not be feasible.

LOCAL CONCERN – Citizens and city officials are concerned about the probable negative spiral effect that another major flood or floods would have on the community. Specifically, if a major flood breached the existing temporary levee system, many structures would be damaged to the point where they would need to be condemned and removed. Another traumatic flood event with damages at Roseau would be difficult to overcome. From social and economic perspectives, the concern is that future significant flood damages would significantly decrease available housing, decrease community and neighborhood cohesion, adversely affect local property value and the tax base, and likely result in a decline in the community population. It could also have adverse effects on regionally significant business, especially the Polaris plant in Roseau.

OPPORTUNITY – To identify and analyze structures in and around the river that contribute to the flooding problems.

As an example, during the 2002 flood, considerable stage increases were associated with the existing in-town railroad bridge. The local desire is to remove the bridge or enlarge the embankment opening at that bridge to help reduce flood stages in town. This problem was evaluated as part of this feasibility study, and no modifications to the railroad bridge have been determined to be incrementally feasible, nor were modifications to any other structures.

OPPORTUNITY – An opportunity to pursue recreation, ecosystem restoration, and aesthetic features in the project area exists.

The Corps and the city of Roseau conducted public and design team workshops to look at potential future community recreation and environmental quality measures. As a result of these discussions, the city asked that recreation, ecosystem restoration, and aesthetic features be evaluated and integrated into plan formulation. These potential features have been evaluated, and recreation has been included in the recommended plan.

OPPORTUNITY – The city of Roseau has fiscal and political support from the State of Minnesota, increasing the financial resources available for this plan.

Water resource studies conducted by Federal, watershed, State, and local levels of government have identified flooding at Roseau as a critical problem in the Red River basin. Accordingly, Minnesota has taken steps to assist flood-prone cities, including Roseau, in funding Federal flood damage reduction studies and in preparing detailed design reports and plans and specifications. The State has also indicated a willingness to assist in the construction of project features to substantially reduce the city's financial costs. The combined financial resources of identified non-Federal and Federal sponsors make a significant permanent flood damage reduction project possible.

OPPORTUNITY – Historically/culturally significant structures could be protected from high risk of flooding as a result of implementing a major permanent project. This project would provide an opportunity to protect those structures from future floods.

OPPORTUNITY – Establish or improve the riparian corridors along waterways (including ditches); encourage the use of native vegetation. Native vegetation will be used in the recommended project area. Further opportunities will be limited because ecosystem restoration features will not be pursued.

Array of Plans Considered

Corps-wide planning guidance, public and interagency inputs, and sound planning principles require screening of an array of possible alternatives. Accordingly, an array of potential permanent Federal plans was specifically considered at various times during the plan formulation process. Specific flood damage reduction strategies that were identified and considered for incorporation into the Roseau plan formulation included the following:

1. No action alternative, which would rely on flood insurance and flood emergency actions in the study area.
2. Nonstructural alternatives that would rely on flood proofing actions in the study area.
3. Upstream floodwater storage features (reservoirs) as a primary and secondary flood damage reduction strategy for the Roseau area.
4. A series of large diversion plans, including west and east diversions, that would divert flows from the main channel of the Roseau River around the city of Roseau.
5. A permanent levee/floodwall system to provide flood reduction capacity. Both 100-year and 500-year floods were considered. This alternative would upgrade and expand the city's current temporary levee system.
6. A series of smaller diversion plans, including north and northeast diversions, that would be shorter in distance than the larger diversions and would also rely on diverting flows from the main channel.
7. A variety of in-town channel modifications were considered. These modifications were largely integrated with the permanent levee plans.

8. Two downstream high-flow channel cutoffs. These cutoffs would bypass flows once the 3-year or 5-year flood stage is realized.
9. Railroad bridge modifications were considered. Public input indicated that the bridge was acting as a constriction point. This alternative was considered as a primary and secondary flood damage reduction strategy.
10. Ecosystem restoration, recreation, and greenway features were considered as optional features that could greatly enhance the overall beneficial effects of the project.

Sequence of Screening Efforts

The general formulation strategy and sequence of the plan formulation used for this study were as follows:

- Define array of possible primary and secondary features. These features were considered as measures that could potentially address some of or all of the planning objectives, opportunities, and concerns. See below for a description and list of plans considered.
- Analyze a range of capacities/sizes for each identified feature as a standalone feature (examining cost and benefits, engineering effectiveness, and social and environmental impacts); that is, how effectively can they meet the goals and objectives of the study while maintaining the economic, social and environmental criteria.
- Determine the most cost effective size for each feature by comparing net benefits associated with each feature (Note: this process is used to establish project feature sequencing with the feature having the highest net benefits being the first in place).
- Determine the extent that this cost effective sized feature could meet the overall project design objectives. Those features that are primary features would significantly solve the problem defined; secondary/lesser features are ways to fine-tune the formulation.
- Identify combination plans of primary features and rank features using relative net benefits as the ranking method.
- Analyze the combined plans to optimize the primary features
- Analyze the secondary features as add-on features to see if, when added, each is incrementally justified – as last in place features thereby optimizing the formulation as the NED plan.

- Determine the overall level of flood damage reduction the NED plan would provide and compare that to the desired project design objectives.
- Coordinate with sponsors and stakeholders to determine if optional aesthetic, recreational and environmental restoration features are to be integrated into a multipurpose project and show the feasibility of any recreational or environmental increments to be added to the NED plan.
- Define the recommended plan, conferring with the non-Federal sponsors to determine if they have an LPP and to integrate fully coordinated multipurpose features, as desired by sponsors.
- Document the recommended NED/LPP plan.

The initial and final screening of alternatives documented in this report was done consistently to allow consideration and comparison of a variety of possible alternatives. The alternatives were analyzed in a similar manner with a similar level of detail, and results were based on project functionality, costs, and environmental and social impacts. Those alternatives that were not eliminated from consideration were analyzed in greater detail as the formulation process progressed. The cost estimate for the recommended plan presented in this report was done at a Microcomputer Aided Cost Estimating System (MCACES) level of detail. This report includes an environmental assessment, and, if appropriate, the Finding of No Significant Impact (FONSI) will be signed following the required public and interagency review periods.

Plan Descriptions

The results of past flood damage reduction studies conducted on the Red River and more specifically in the Roseau River watershed were researched for possible application, and many possible flood damage reduction strategies were considered for implementation at Roseau. Alternative flood damage reduction plans and features that were identified during the reconnaissance phase/Section 905(b) analysis study have also been reviewed, refined, and further evaluated.

Scoping meetings were held with the public and agency representatives to help identify existing and future without project conditions, water resources problems and opportunities, and possible alternative flood damage reduction solutions. This process has led to identification of additional flood damage reduction features that have been added to the array of alternatives evaluated and screened.

A graphic (figure 2) shows the various diversion plans that were considered in this feasibility study screening. The in-town levee alternatives, not labeled in figure 2, were to follow the alignment of the river.

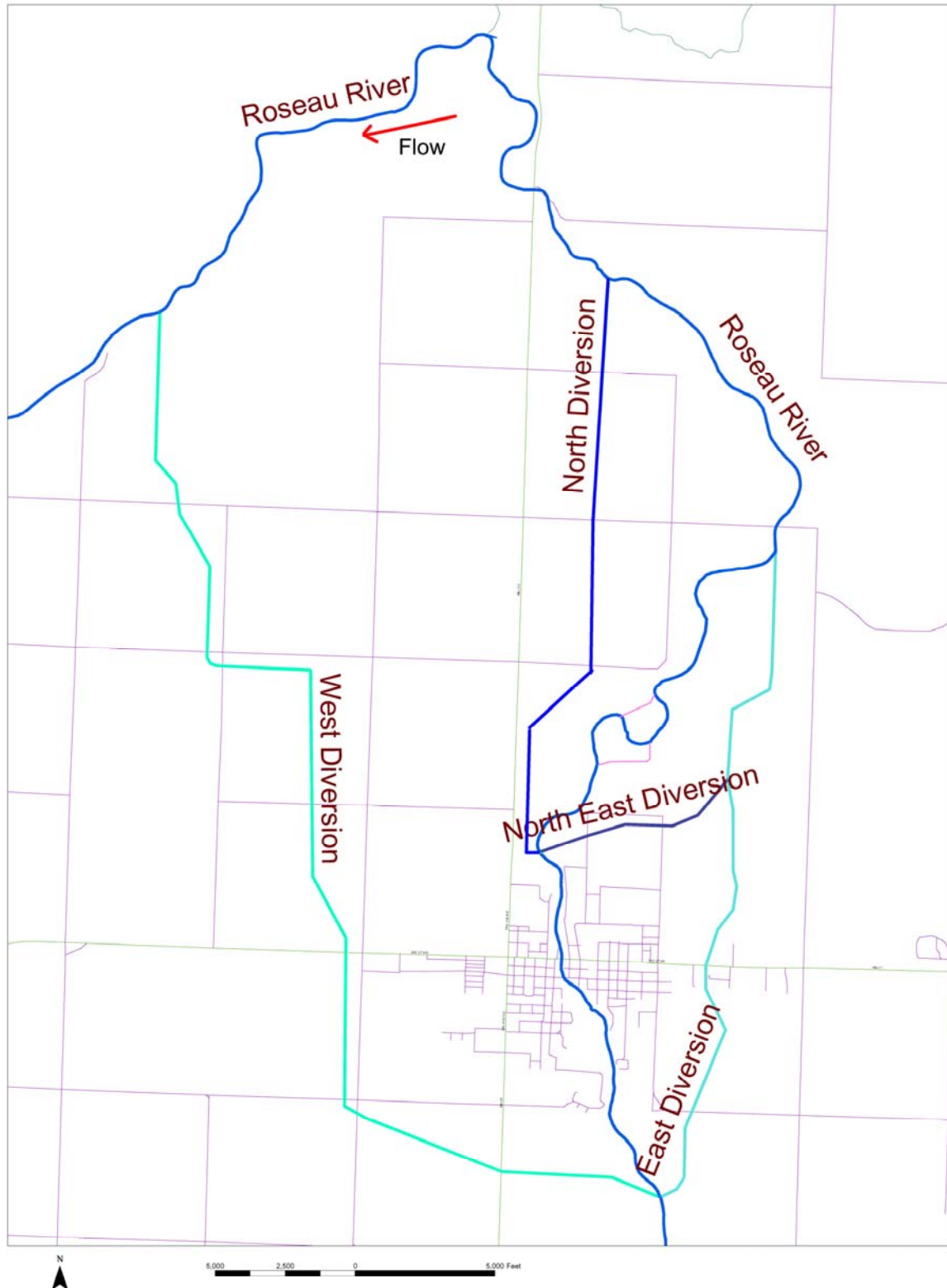


Figure 2 - Alternatives Considered

It is important to note that the flood damage reduction alternative measures considered would provide enough flood damage reduction so as to be primary features, and other measures evaluated could only be viewed as secondary features that might be used in combination with primary measures (for example, modification of the railroad bridge could only reduce flood stages by 0.2 to 0.3 foot for a small downstream reach and could not physically meet the flood damage reduction objectives as a primary feature because it would not be a solution as a standalone plan). The secondary features that were eliminated as standalone plans were further analyzed during optimization of the selected plan.

Initially, the project delivery team developed a list of possible alternatives that could potentially meet the goals and objectives of the project, while being economically, environmentally, and socially feasible. In addition to the initial plans, some proposals were added to the screening as a result of increasing knowledge of the project area along with public and interagency inputs. The following is a list of those potential flood damage reduction plans.

- No action
- Upstream floodwater storage
- Permanent levee/floodwall system
- West aligned diversion plan
- East aligned diversion plan
- North aligned diversion plan
- Northeast aligned diversion plan
- Channel modifications/riverbank unloading
- High-flow cutoff channels
- Railroad bridge modifications
- Nonstructural measures

In addition to the potential flood damage reduction plans, ecosystem restoration and recreation/greenway features were included as possible standalone features that would add to the overall viability and desirability of the project. A brief description of the plans considered is provided below:

No Action Plan

The no action plan would result in the Federal Emergency Management Agency (FEMA) establishing a new regulatory floodplain with a large portion of the city in the regulatory floodplain. The city would continue to rely on heroic flood fighting efforts and emergency levees, which are prone to failure, to combat floodwaters. Expected average annual damages from this alternative would be \$2.5 million. This condition would continue to have negative social and economic impacts on the city and its populace. Roseau would continue to be susceptible to flooding and future damages would continue. It is anticipated that environmental damages would result during large floods where sewage and other contaminants could be released.

Upstream Floodwater Storage

Upstream floodwater storage would require holding back significant amounts of water in a reservoir and releasing the water after the flood threat had subsided. This water retention could be done with a dam or other structure to hold back flows upstream of Roseau. This plan would require an impoundment structure and large areas of land, resulting in relocations and potential environmental effects. This alternative could alter high quality riverine and wetland habitats.

Diversion Plans

The diversion plans were looked at in four primary areas. The concept behind these plans was to divert flows from the main channel through a diversion to reduce stages in town. Options for diverting flows upstream of Roseau were the east and west aligned diversion. The north and northeast diversions were designed to divert flows downstream of Roseau. These plans all would have similar social and environmental effects, primarily depending on the length of the diversion being proposed. The west diversion plan was significantly longer than the other diversions and would have the most environmental effects on woodland and wetlands. The other diversion plans considered (north, east, and northeast) were all similar in length and would have similar social and environmental effects, primarily minor effects on woodland and wetlands, with no measurable loss in habitat. Each of these plans would include a channel, inlet and outlet structures, a restriction bridge, highway bridges and a railroad bridge (east and west diversion only).

Levee/Floodwall Plans

The levee/floodwall plans were proposed to hold back floodwaters as they encroached on the town. The plan called for the alignment to follow the river through town. The city already had existing emergency levees in place that would need to be analyzed (see the geotechnical appendix (Appendix G) for analysis). This alternative would include a series of main levees, tieback levees, closure structures, and possible pump stations. It would require the removal of a number of structures as the levee/floodwall would need to be set back from the river because of geotechnical conditions along the river channel. In addition to the large social effects, the river channel itself would need to be modified, which would affect large amounts of riverine habitat and permanently alter the river channel.

Channel Modifications

Channel modifications would have been designed to increase the efficiency of the channel. This alternative would straighten the river channel and would require some disposal areas for the excavated material. These plans could also be incorporated into the levee/floodwall plan to cut back the river side slope to accommodate the setback levees. As indicated with the levee/floodwall plan, this alternative would have large impacts on riverine habitat by permanently altering the river channel.

High-Flow Cutoff Channels

The high-flow cutoff channels concept was similar to that of the diversion channels but significantly smaller in size. Two channels located downstream of Roseau were considered. These channels would be designed so high flows would be able to move downstream faster than the without project condition. This alternative was designed to cut off two oxbows and would need an inlet and outlet at each cutoff. This alternative would have minimal social effects and environmental effects would be confined to the inlets, outlets, and channel cut.

Railroad Bridge Modifications

The railroad bridge modifications were proposed later in the planning process. It was discovered that the railroad bridge was acting as a bottleneck, and modifications to remove the bottleneck could potentially have positive results. This alternative was raised in public meetings and would alleviate some concerns the local citizens have about the railroad bridge. This alternative would have minor environmental effects because the area is already disturbed by the presence of the existing structure. This plan could also be a secondary alternative that could enhance the performance of another alternative.

Nonstructural Measures

The nonstructural measures were considered as a potential way to protect the city from flooding while avoiding a large construction project. Some possibilities would be flood proofing the structures, relocations, or utility relocations. This alternative would have a large social impact because the majority of the city is in the 100-year regulatory floodplain. On a small scale, the nonstructural solutions would be more socially desirable, and this alternative could be used to optimize other alternatives.

Ecosystem Restoration

Ecosystem restoration was considered as a possible way to enhance the overall project. Ecosystem restoration would have been in addition to the flood damage reduction portion of the project, and opportunities were present to restore habitat in areas that are currently marginal farmlands. This alternative would be a good way to enhance the environment in the region, providing additional high quality habitat near the city.

Recreational Features

Recreational features were considered as a way to enhance the overall project. The Roseau area is in rural northern Minnesota, and very few recreational opportunities are present in the area. The market area for Roseau would be those areas within a 1-hour drive. Potential features were multipurpose trails, off-road vehicle trails, a canoe trail, and camping facilities. Tree and native plantings would be used to enhance the overall recreational experience; these plantings would have some beneficial effects on the

environment. Socially, recreation features are very desirable and have been met with strong support from the city of Roseau and the citizens in the region.

Once the plans were defined, the project team did a preliminary analysis to eliminate those plans that conceptually would have extremely large costs and would not be expected to have a significant amount of flood damage reduction benefits (see table 1). It was determined that the upstream floodwater storage, channel modifications, and nonstructural measures would not be economically feasible because of their large costs or limited ability to reduce stage.

Table 1.

Measure	Reason for Elimination
Upstream Flood Water Storage	<ol style="list-style-type: none"> 1. The upstream storage would be very costly and have minimal ability to reduce the river stage in Roseau. 2. Much of the watershed is flat and creating a reservoir could have large environmental and social effects.
Channel Modification	<ol style="list-style-type: none"> 1. Channel modifications would have high environmental impacts with minimal ability to reduce stage. 2. The ability to reduce stage would only be in limited areas, and overall net benefits are low with this alternative. 3. This plan was dropped as a standalone plan but will be considered with the levee alternatives.
Nonstructural measures	<ol style="list-style-type: none"> 1. Flood proofing is cost prohibitive because of the large numbers of properties due to the flat topography in the project area. 2. Relocations or buyout measures are not feasible because the majority of the city will be in the regulatory floodplain and the costs of relocating the city would not be justified. 3. This plan was dropped as a standalone plan but will be considered as a way to optimize future plans

Following the preliminary analysis, the project team conducted an initial screening of alternatives. This screening was designed so that the flood damage reduction outputs of each feature were compared against other flood damage reduction measures/plans with similar outputs. This way, the screening could eliminate alternatives that realized the same flood damage reduction output at greater expense. An example of this process is that the east diversion and west diversion would have similar affects on stage, but the west diversion would be much longer and have higher economic, environmental and social costs.

Once the costs were developed for each plan, comparison was done to eliminate those plans that had similar outputs with greater costs, thus fewer net benefits, than a competing plan. This analysis resulted in the following plans being pitted against each other, where those plans with lower net benefits were eliminated (see table 2).

Table 2.

Measure	Reason for Elimination
West Aligned Diversion Channel	<ol style="list-style-type: none"> 1. This alternative is more costly than the East Diversion. Initial estimates indicated that the West Diversion would have at least \$1 million less in net benefits. 2. This plan potentially would have had larger social and environmental impacts than the East Diversion.
North Aligned Diversion Channel	<ol style="list-style-type: none"> 1. This plan had net benefits of \$500,000 less than that of the East Diversion Plan. 2. The plan did not remove the majority of the city from the 100-year regulatory floodplain, with diminishing impact going upstream of the inlet.
Northeast Aligned Diversion Channel	<ol style="list-style-type: none"> 1. This plan had net benefits of \$400,000 less than that of the East Diversion Plan. 2. The plan did not remove the majority of the city from the 100-year regulatory floodplain, with diminishing impact going upstream of the inlet.
High Flow Cutoff Channels	<ol style="list-style-type: none"> 1. This plan had net benefits of \$120,000 less than that of the East Diversion Plan. 2. The plan did not remove the majority of the city from the 100-year regulatory floodplain, and had minimal effect on stage.
Railroad Bridge Modifications	<ol style="list-style-type: none"> 1. Analysis revealed that modifications to the bridge would only have minor effects on stages. 2. Although a fairly cheap alternative, this plan had \$-194,000 in net benefits. 3. This plan is unable to remove the majority of the city from the 100-year regulatory flood plain. 4. This plan was considered in the optimization of the selected plan.
Ecosystem Restoration	<ol style="list-style-type: none"> 1. It was determined that ecosystem restoration although possibly feasible, would not result in significant net benefits to the region. This is due to the rural nature of the region and the large amount of pristine ecosystems in the region. In addition the local sponsor was not as interested in this project option. 2. It is anticipated that some of the project lands will return to natural conditions by changing their current land use. 3. The project team will continued to look for possible environmental opportunities, although not as a stand alone feature.

Plan Comparisons

The **east and west major diversion plans** were compared against each other. Each of these alternatives could provide a high level of flood damage reduction to large portions of the study area. Each plan would have similar features (inlet and outlet structures and railroad and highway bridges) and would begin to carry flows at approximately the 2-year event. The west diversion plan would be approximately twice as long as the east diversion plan resulting in a larger footprint and more social impacts. In addition, the habitat along the proposed west diversion alignment is of higher quality than that along the east diversion, which would mainly cut through agricultural fields.

Smaller Diversion Plans and Cutoff Channels – Initially, the smaller north diversion, northeast diversion and two high-flow cutoff channels were compared against each other. These features provided the opportunity for limited flood damage reduction to small portions of the study area. As a result, it was determined that these alternatives would not significantly reduce flood stages and would not be as efficient as the larger diversion channels. Therefore, these alternatives were removed from further analysis.

In addition to comparing those plans with similar functionality, the **railroad bridge modifications** were identified as having potential as a standalone or secondary feature. After analysis, it was determined that the railroad bridge modifications would have minimal ability to reduce river stage and were dropped as a standalone feature.

At this time, **ecosystem restoration** was eliminated from consideration as a project purpose. It was determined that ecosystem restoration would provide minimal additional benefits to the project if it were pursued, partially because of the location of the project area in pristine northern Minnesota, and it is expected that much of the project area would return to more natural conditions over time. In addition, the non-Federal sponsor was not as interested in this project option.

Following this initial screening, only the **levee/floodwall and east diversion** plans remained. During the final screening, another detailed round of cost and benefit analyses were conducted on these features. In addition to analyzing the remaining plans as standalone plans, secondary features (such as railroad bridge modifications and nonstructural solutions) were examined as potential ways to increase the net benefits of these plans.

The two remaining plans were each analyzed at three different levels of protection. The levee alternatives were analyzed at the 25-, 100-, and 500-year levels of protection, while the east diversion was analyzed with 50-, 150-, and 350-foot bottom widths (see table 3). It should be noted that the bottom widths do not perfectly correlate with the 25-, 100-, and 500-year events analyzed for the levee alternatives.

Table 3.

Table 3.		
Measure	Initial Estimated Benefits	Reasons for Elimination
Levee/Floodwall 25 year 100 year 500 year	/1 < \$188,000 < \$1,189,000 < \$1,074,000	1. Overall the Levee/Floodwall alternative had less net benefits than the East Diversion. 2. This alternative has significantly higher social and environmental costs. 3. Information on setback levees was determined after cost estimates were developed which would result in net benefits lower than those indicated in table 3.
		Reasons for Selected Plan
East Diversion 50 foot 150 foot 350 foot	\$1,103,000 \$1,210,000 \$924,000	1. Highest net benefits. 2. Meets the goals and objectives of the project. 3. Provides ability to fight floods larger than design event. 4. Environmentally and Socially acceptable.

/1 - Project costs were underestimated, so net benefits are actually less than shown.

As seen in table 3, the east diversion channel would have higher net benefits than the levee/floodwall alternative. However, the results are very close, and it is important to note that, following the development of the costs for these alternatives, it was discovered that the levee/floodwall alternative would have many additional costs because of increases in setback requirements for the levees. This additional setback would have resulted in the need for additional lands and the purchase of many structures, which would make it both economically and socially unacceptable.

Identification of the Selected Plan

On the basis of these screening evaluations, it is clear that, of the primary features evaluated, the upstream storage, west diversion plan, north diversion plan, northeast diversion plan, downstream high-flow channel cutoffs, and in-town levee system plans are not feasible or are less efficient than the east diversion plan (that is, the east diversion would have the greatest net benefits, would be socially more desirable, and would have fewer environmental impacts). Modifications to enlarge the existing river channel and modifications of the railroad bridge would not be feasible as standalone features. Accordingly, those screened-out features did not warrant further evaluations or design as primary solutions. The primary flood damage reduction plan warranting further detailed evaluation and optimization was the east diversion plan (this plan was the “selected plan” and the focus of more refined designs pursued during the feasibility study).

Selected Plan Optimization (NED Plan)

After public comment and discussions with the non-Federal sponsors following the presentation and distribution of the alternatives screening report (April 2005), the selected plan was defined and refined in April and May 2005.

Once the selected plan was fully defined, the study team began plan optimization. The optimization effort is a Federal requirement that is needed to identify the NED plan. This NED/optimized design is typically the plan the Federal Government recommends for construction. Generally, the cost of implementing the NED plan is the level of Federal interest in funding a water resource project.

Federal and Corps of Engineers planning procedures require the formulation of an NED plan. The NED plan is an optimized plan that provides the greatest net benefits and has a benefit- cost ratio of at least 1.0. Any requested deviations and/or locally requested betterments are compared to this plan.

To define the NED plan, it was necessary to optimize the selected east diversion plan. Prior to optimization, many small changes were made to this plan to accommodate public, landowner, task force, and interagency input. These changes resulted in a slightly different alignment for the diversion channel inlet and the lowering of a driveway for overland flows. These changes enhanced the project and made it more socially acceptable by avoiding the taking of homesteads.

Once these changes were incorporated, the project team began to optimize the east diversion plan. The team analyzed some of those features that were dropped as standalone features but might be used to gain additional benefits from the selected plan. Railroad bridge modifications, nonstructural solutions, and small in-town levees were considered as possible ways to optimize the selected plan. These secondary features need to have positive net benefits to be included in the final recommended plan.

The project team proceeded to analyze the east diversion plan at three points with channel widths of 50, 150, and 350 feet. After thorough analysis of economic, visual, and hydrologic information, it was determined that the 150-foot bottom width plan was the plan with the most net benefits.

To determine the NED plan, the study team used the expected outline of the 100-year flood (1-percent exceedance frequency) with the diversion in place to determine if all the study goals were met by the proposed diversion. Through this analysis, it was determined that a few structures would remain in the floodplain at their lowest adjacent grade.

On the other side of the issue, because of the sensitivity in the region, a channel with a width less than 150 feet would not be warranted because increasing the number of affected structures would overwhelm the city's ability to fight the flows created by the connectivity of the city sewer systems. On the basis of the analysis and findings of the optimization for the east diversion, the 150-foot bottom width is the optimized size for the east diversion channel.

However, analysis indicated that the 150-foot plan would result in residual damages of nearly \$313,000 annually. In an attempt to reduce the residual damages and improve the overall plan the project team analyzed three secondary features--small in-town levees, railroad bridge modifications, and non-structural measures--which could be added to the 150-foot diversion channel. It was determined that it was not feasible to use these secondary features to improve the overall project performance, because they did not provide any additional net benefits to the project (see table 4). The small in-town levees would have high costs due to the requirement that the levees be set back from the river channel. The railroad bridge modifications would have very minimal effects on the river stage, resulting in no net benefits. The non-structural solutions were the most promising of the three secondary features, however they resulted in a net loss of \$1,000 annually and therefore are not part of the NED plan. Therefore, the 150-foot bottom width plan is the optimized NED plan.

Table 4.

Measure	Reason for Elimination
Small In-Town Levees	1. It was determined that these levees would be subject to similar setback requirements as the larger in-town levee plan, thus there would be large costs and social impacts.
Railroad Bridge Modifications	1. These modifications would have minimal ability to reduce stage and only for a small portion of the river. 2. The benefits obtained by the modifications in connection with the East Diversion Channel would be minimal, because the East Diversion already captures most of the benefits.
Non-Structural measures	1. It was determined that the proposed non-structural measures would have no net benefit 2. The small number of structures and the high cost to modify those structures made this option inefficient.

The 150-foot bottom width east diversion channel has been designed to carry flows associated with the 100-year regulatory flood. If a levee were overtopped, the results would be devastating. Diversion channels have no possibility of a catastrophic failure. With the diversion, an overtopping would require additional flood fighting measures, but large loss of life and damages would not be expected. The city would need to be prepared for larger events, such as the 2002 event, that would exceed the capacity of the proposed project. However, the city would be in better position to fight those large events when they do occur. Therefore, the optimized NED plan is the 150-foot bottom width east diversion channel.

Hydraulic modeling of the NED plan showed a 0.1-foot increase in stage downstream of the project area for the 100-year flood event (see the hydraulics design appendix (Appendix B)). The non-Federal sponsor and public input indicated that downstream impacts resulting from the project would be unacceptable. This input resulted in the addition of two storage areas that were designed to remain dry until floodwaters would spill over weirs filling the storage areas. The addition of these storage areas eliminated any downstream stage increases caused by the 150-foot bottom width NED plan. It was determined that the inclusion of the storage areas was not part of the NED plan because they would have no measurable downstream economic impacts as a result of the small frequency of minor stage increases being caused by the NED plan. Therefore, the additional costs of the storage areas were not justified, because they would not prevent any economic damages.

The non-Federal sponsor indicated that, even though the storage areas would not be part of the NED plan, it wanted to include them in the project and formally requested that the recommended plan be the NED plan with additional storage areas. This LPP is the recommended plan, and the additional cost increment associated with the LPP will be borne 100 percent by the local sponsor.

This recommended plan meets all the planning goals of the city, State, and Federal Government. In addition to flood damage reduction features, the recommended plan contains numerous recreational features; these features have been determined to be economically feasible and are supported strongly by the city and the local citizens of Roseau. See the recreation appendix (Appendix I) for an overview of the recreational features.

Detailed Description of the Proposed Project

NED Plan and LPP Features

The optimized east diversion plan defined in the final screening has had additional design, resulting in more accurate costs, and has been assessed from an environmental perspective in the final phase of the feasibility study plan formulation. The NED and recommended LPP are presented in figures 3 and 4 (see plates 1a through 5a in the plan plates section of this report for the LPP and plates 6 through 10 for the NED plan). The proposed alignment was determined by using engineering expertise along with public and agency inputs. The proposed alignment would meet the goals of the project, minimize environmental and social impacts, and adequately protect the city from future floods.

The east diversion plan, referred to as the NED plan, is a multipurpose flood damage reduction project with associated recreational features (figure 4). The flood damage reduction portion would provide permanent flood protection for nearly all areas of Roseau, while the recreation portion would benefit the city and surrounding area by providing numerous recreational activities and tying into other recreational features in the region. The plan includes plantings of native tree, shrub, and grass species that would be used throughout the project features, which would consist of a permanent diversion channel to the east of the city. This plan would remove a substantial portion of Roseau from the 100-year regulatory floodplain and would also significantly reduce flood stages as far upstream as Malung dam. Because the NED plan is a diversion and not a levee system, the consequences of an overtopping would not be catastrophic, but nonetheless a threat, and the non-Federal sponsor would need to continue to be proactive in its measures to prevent future flooding. The alignment chosen would provide the city the ability to implement future flood fighting measures in case of a very infrequent flood event that would exceed the design capacity of the permanent project. The city has requested that the recommended plan include two large storage areas to eliminate any downstream stage increases as a result of the project. Therefore, the recommended plan is the east diversion channel with storage areas. This plan, described below, would function the same as the NED plan providing the same benefits with the city of Roseau paying the additional costs.

The recommended plan would divert the waters of the Roseau River to the 4.5-mile diversion running parallel and to the east of the Roseau River. The diversion channel would split from the river at the city park flowing north until returning to the river just upstream from the confluence of the river and Hay Creek. The entrance to the diversion would be set to elevation 1042.0 feet, roughly equivalent to the 2-year channel forming event. Splitting the flows would decrease the amount of water being carried in the main channel. To provide more efficient use of the diversion channel, a restriction bridge, as it is being called, would begin to restrict the flows on the main channel of the river at the 5-year flood event (20-percent exceedance frequency). The channel would have a bottom width of 150 feet and 1V:5H side slopes. The channel invert would drop approximately 1 foot on a slope of 0.000256 from the channel entrance to the railroad bridge, located approximately 1 mile down the diversion channel. The channel bottom would be horizontal from this location to the point where it would begin a descent toward the

confluence with the Roseau River, a distance of about 1,000 feet. During this distance, the depth of the diversion would go from 16 feet to areas where no channel cut is needed.

The channel would be formed by excavating into the existing topography. Upstream of Highway 11, the channel would be cut as much as 16 feet below the existing ground. From Highway 11 north, the channel cut would become increasingly shallow as the channel invert elevation approaches the land surface elevations. The bottom width of the channel would be a constant 150 feet, truncating to 125 feet at the bridges, but the top width would vary between 300 and 150 feet depending on the elevation of the adjacent land areas. In the reaches of the diversion corridor north of Highway 11, the flow would transition from flow in a channel to overland floodplain flow. In this section of the corridor, the flow would be confined within a floodplain corridor by diversion levees as described below. Just downstream of the northern end of the wastewater treatment plant, the confined channel would disappear and the water would be free to spread across the terrain. On the northern edge of this area, adjacent to the Roseau River, a sloped (0.01V:1.0H), 150-foot-wide, 1,000-foot-long, grass-lined channel would be constructed to allow the water from the diversion channel to re-enter the river. The channel dimensions for this segment are 1V:3.5H side slopes with a bottom width of 150 feet. Surplus material excavated in the construction of the diversion channel would be spread on adjacent farm fields at the southern (upstream) end of the diversion. Approximately 120 acres covered to a depth of 4.5 feet would be needed to dispose of the material, which would be shaped and vegetated to accommodate recreation activities, among others.

Approximately 9 miles of diversion levees would be constructed to the east and west of the diversion channel to ensure containment of the diversion flows. The levees would be 10 feet wide at the top, would have a 1V:3H side slope and would cover 48 acres including 11 acres of road raises. The levee east of the diversion channel would ensure that properties to the east would not be adversely affected by the project. The east diversion levee would extend to the north and east from Highway 11. The first segment would end at County Road 28, which would tie into high ground to the south. The second segment of levee would begin near the airport, 1 mile to the east. This levee would encompass the largest of the storage cells (see below). The levee would extend north along Township Road 338, then west for 1 mile and then north again. This portion of the levee would block the diversion flows from entering Hay Creek. The levee would end at the Roseau River just downstream of its confluence with Hay Creek.

The levee west of the diversion channel would prevent the water in the channel from flowing back toward the main river channel north of the city and would maintain the flow parallel to the river within the floodway. This levee also would prevent diversion flows from backing into town. It would begin near Highway 11 and continue generally to the north to the high ground above the Roseau River bank about 1 river mile upstream of the confluence with Hay Creek. The area between the two diversion levees would encompass the diversion corridor as well as the storage cells (see below).

Three wooded areas are along the length of the diversion channel and levees. Trees within the footprint of these structures would be removed. Upon completion of construction, these areas would be seeded with native grasses. Trees would be planted at various locations along the floodway and buffer areas outside of the channels. A substantial amount of the storage and floodway area could be managed for environmental enhancement purposes. Local, State and Federal natural resource agencies would be coordinated with in future project design phases to determine the preferred vegetative species and management practices to use.

Bridges are also proposed to cross the diversion channel at County Road 24, the railroad

tracks, and Highway 11. Abutments of these bridges would be armored with rock. Downstream of Highway 11, a Texas crossing with box culverts would be installed. This crossing would not interrupt flow in the area nor change the post-construction land use. Two roads would be used as is, or slightly raised, as levees for the storage areas. Minimal changes in structure or size would be expected. Highway traffic bypass during construction would be handled with detours rather than construction.

To increase the efficiency of the diversion channel and add additional protection for the downstream community, a restriction bridge would be constructed just downstream from the entrance to the diversion channel. This restriction would raise the water in the channel, thereby increasing the energy available to drive water through the diversion channel. The proposed structure would be similar to a roadway bridge abutment with a 16-foot-wide bridge deck. The flanks of the restriction would extend across the valley at elevation 1053.5. The gap left by the opening would have a width of 100 feet and a bottom elevation of 1030.0. The structure would not begin to affect existing flow conditions until approximately the 5-year flood event. The head losses at the structure for various year events are presented below.

Head Loss at River Restriction Bridge

Year Event	2- Year	5-Year	10-Year	20-Year	50-Year	100-Year
Head loss	0.01 foot	0.02 foot	0.10 foot	0.17 foot	0.27 foot	0.38 foot

Rock protection would be placed in the existing river channel from just upstream of the structure to approximately 50 feet downstream from the structure. Sufficient existing substrate material would be removed to allow for the placement of the rock riprap protection while still maintaining the existing river bathymetry. The resulting river stages upstream of the entrance to the diversion channel for any flow would be lower than existing conditions because of the water being diverted into the diversion channel.

The presence of the diversion channel alone would slightly increase the hydrograph of the Roseau River during high flood events downstream of the confluence of the channel and river. To maintain the existing hydrograph, additional storage/ponding areas have been added to the alternative plan, as requested by the non-Federal sponsor. The storage areas would be located on either side of the 1,000-foot-wide diversion corridor north of Highway 11. These storage areas would be inside the main levees described above but isolated from the diversion channel by an additional set of lower, intermediate levees. Land within the storage levees would remain dry for all but large floods. During floods, beginning at the 20-year frequency, discharges would reach the height of an earthen, rock protected spillway at the upstream end of the storage levee and a portion of the flow would spill into the storage areas. This water would collect in the levee-bound areas until river stages had receded enough so that the water could be released through rock-protected control structures in the levees. The peak stage downstream of the project would be unchanged with the addition of storage cells.

The project would not have any adverse effects outside the immediate project area and would have minimal adverse effects on natural resources in the area. The project alignment has been designed to avoid disturbance of natural resources as much as possible. All areas disturbed during construction would be planted with native vegetative species, and opportunities to establish additional natural habitat would be explored. Such opportunities are likely to be successful given the amount of previously farmed land that would become part of the project area. Cultural resources have been previously found in the area; a survey would be conducted and, if any cultural resources were found, the project would be modified to avoid them if possible. If avoidance was not possible, the resource loss would be mitigated. The project has

been designed to minimize adverse effects, and this effort would continue during preparation of plans and specifications.

The proposed recreation features would include multipurpose trails for pedestrians and bicycles that would use the project corridor for a total length of approximately 7 miles. These trails would be either paved or constructed of compacted gravel. During the winter, cross-country skiers and snowshoe enthusiasts would use these trails. Off-road vehicle trails are also included in the design to take advantage of the local recreational pastime and prevalence of off-road vehicles due to the Polaris facility which produces snowmobiles and all-terrain vehicles. These trails would be separate from the other trails and would be nearly 9 miles long. See figure 5 for a visual on the proposed recreation plan.

The recreation plan includes a trailhead that would include restrooms, potable water, picnic facilities, and parking. Additional aesthetic features would consist of 5 acres of hardwood plantings and 25 acres of saplings along the trails to act as buffers.

During the planning process, the east diversion plan was refined with inputs from the public, sponsors, stakeholders, and affected landowners and became a multifeatured east diversion plan with storage areas and recreational components. Components of the LPP and NED plan are summarized below (see the cost engineering, plan plates, recreation, and environmental assessment appendixes for additional details regarding project features).

Table 5 contains a list of the project features and environmental effects listed incrementally for the NED and LPP. The LPP would affect 9.71 acres of wetlands, 1,200 square feet of riparian habitat, and 11.75 acres of woodlands. The project area, which includes an area 1 mile on either side of the structural features, consists of developed urban area and active farmland. The project area contains 721 acres of woodlands and 136 acres of riparian habitat. The immediate project area contains approximately 32.83 acres of wetlands.

The wetlands in the immediate project area are small and disconnected by roads or agricultural fields, offering limited habitat value. Compensatory mitigation is not necessary for this project; however, construction of the project would create wetland habitat incidental to the project. It is anticipated that the project would have no appreciable effect on the riparian habitat within the project area and that the rocky area would quickly repopulate with benthic organisms and the presence of the rock would increase habitat diversity in this reach of the river. Because 721 acres of woodlands are in the project area, the removal of 11.75 acres of woodlands and replacement planting of 30 acres of woodlands for the recreational features would have no appreciable effect.

Table 5.

Feature	NED	LPP	Total
Acres of Land	763	1089	1852
Miles of Levee	5.1	4.1	9.2
Miles of Road Raise	0.51	0.69	1.2
Spoil Areas	129	-9	120
Gated Culverts	2	0	2
Spillways for storage	0	4	4
Highway Bridges	2	0	2
Railroad Bridges	1	0	1
Restriction Bridge	1	0	1
Diversion Length, Miles	4.5	0	4.5
Inlet Control Structure	1	0	1
Affected Wetlands Acres	8.25	1.46	9.71
Affected Riparian Square Feet	1200	0	1200
Affected Woodland Acres	11.75	0	11.75
Native Plantings, Acres	200	0	200
Tree Plantings (Recreation) Acres	30	0	30

NED Plan Features

- Approximately 4.5 miles of diversion channel (ranging from a maximum depth of 16 feet to areas where no channel cut is needed, with a bottom width of 150 feet and 1V:5H side slopes).
- 129 acres of disposal stockpiles with a depth of approximately 4.5 feet to match levee heights and blend into the naturally flat landscape in the area.
- 763 acres of land acquisition.
- Approximately 5.1 miles of levees used to contain flows within the diversion channel. These levees would have a top width of 10 feet with 1V:3H side slopes. The majority would have a height of less than 5 feet.
- 0.51 mile of road raises ranging from 2 to 4 feet.
- Two gated culverts for maintaining drainage during nonevents.
- An inlet control structure to regulate the events that would pass into the diversion channel, beginning with 2-year frequency events.
- A restriction structure to increase the efficiency of the diversion channel. This structure would be 16 feet wide and 100 feet long. It would begin to restrict flows at the 5-year event (20-percent exceedance frequency).
- Construction of three bridges (two associated with roads crossing the diversion and one railroad bridge crossing the diversion).
- Relocations of electrical, sewer, gas, and telephone infrastructure.

- Riprap at various locations to protect the levees and diversion structures from erosion.
- 8.25 acres of affected wetlands.
- Approximately 200 acres of native plantings to provide ground cover in the project area.
- Lower driveway (0.6 foot) on west side of river to maintain existing breakout flows.

LPP Features (Changes to NED Plan)

- Approximately 4.1 miles of additional levees used to contain peak flows within the storage areas. These levees would have a top width of 10 feet with 1V:3H side slopes. The majority would be less than 5 feet, the highest would be 15 feet.
- Approximately 5.1 miles of reduced levee heights; the reduction would vary from 2 to 5 feet (see NED plan features above).
- 1,089 acres of additional land acquisition for storage areas and associated levees.
- 0.69 mile of additional road raises ranging from 2 to 4 feet.
- 9.0-acre reduction in disposal stockpiles; the material would be used in levee construction.
- Four additional spillways along the levee system to allow for peak flow storage.
- 1.46 additional acres of affected wetlands.

Recreation Plan Features

- Three multipurpose recreational trail loops combining for a total of approximately 7 miles of paved or compacted gravel trails.
- 4.3 miles of canoe trails in two segments, the north being 1.3 miles and the south 3 miles.
- One scenic overlook, two interpretative sites, and birding stations.
- A total of 9 miles of off-road vehicle trails of different levels of difficulty.
- Restrooms, potable water, picnic facilities, grills, and parking at the off-road vehicle trailhead where the project intersects with Highway 11.
- 5 acres of hardwood planting for trail head and park areas.
- Planting of 25 acres of wooded areas near trails.

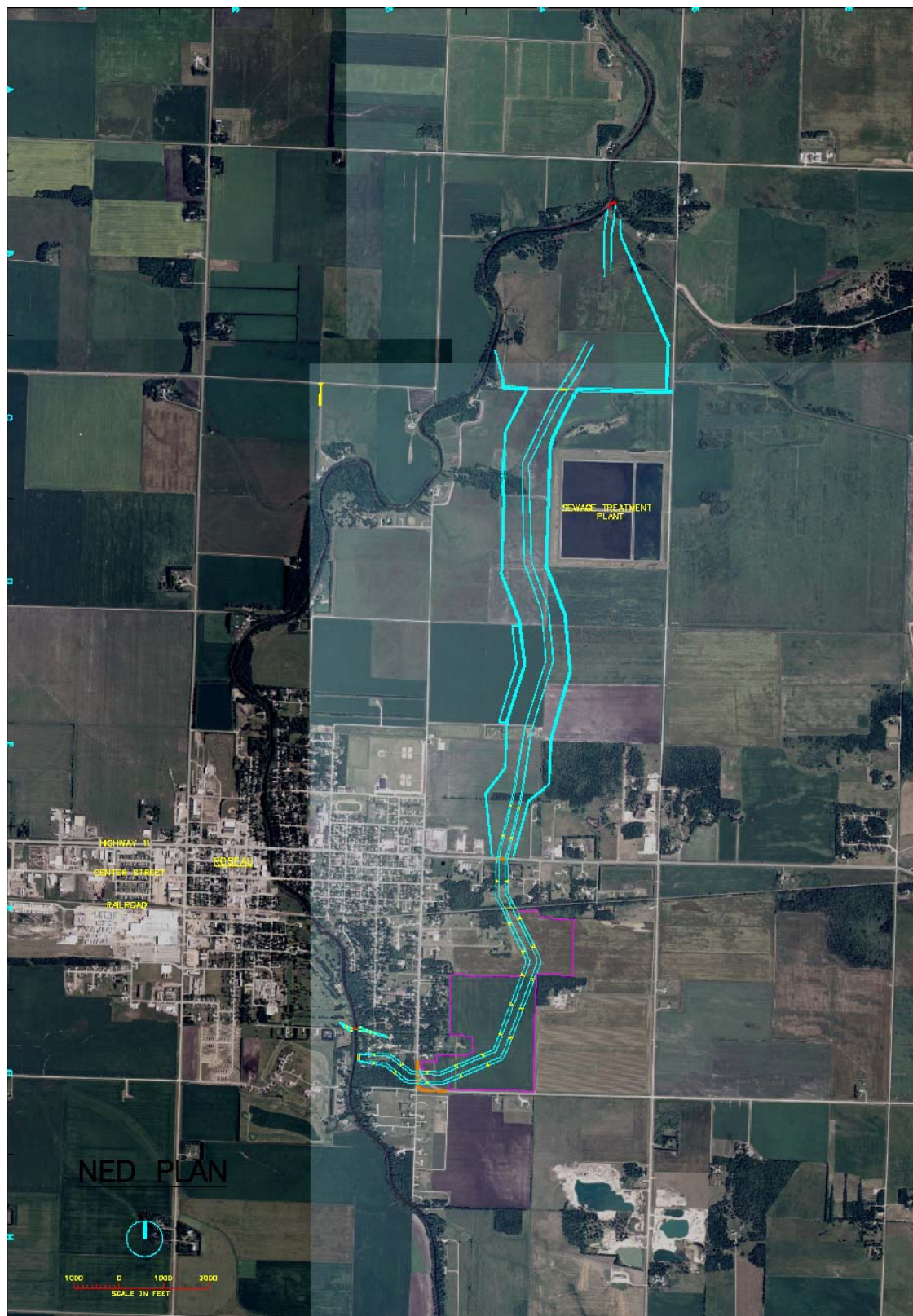


Figure 3 – National Economic Development Plan Alignment and Associated Features

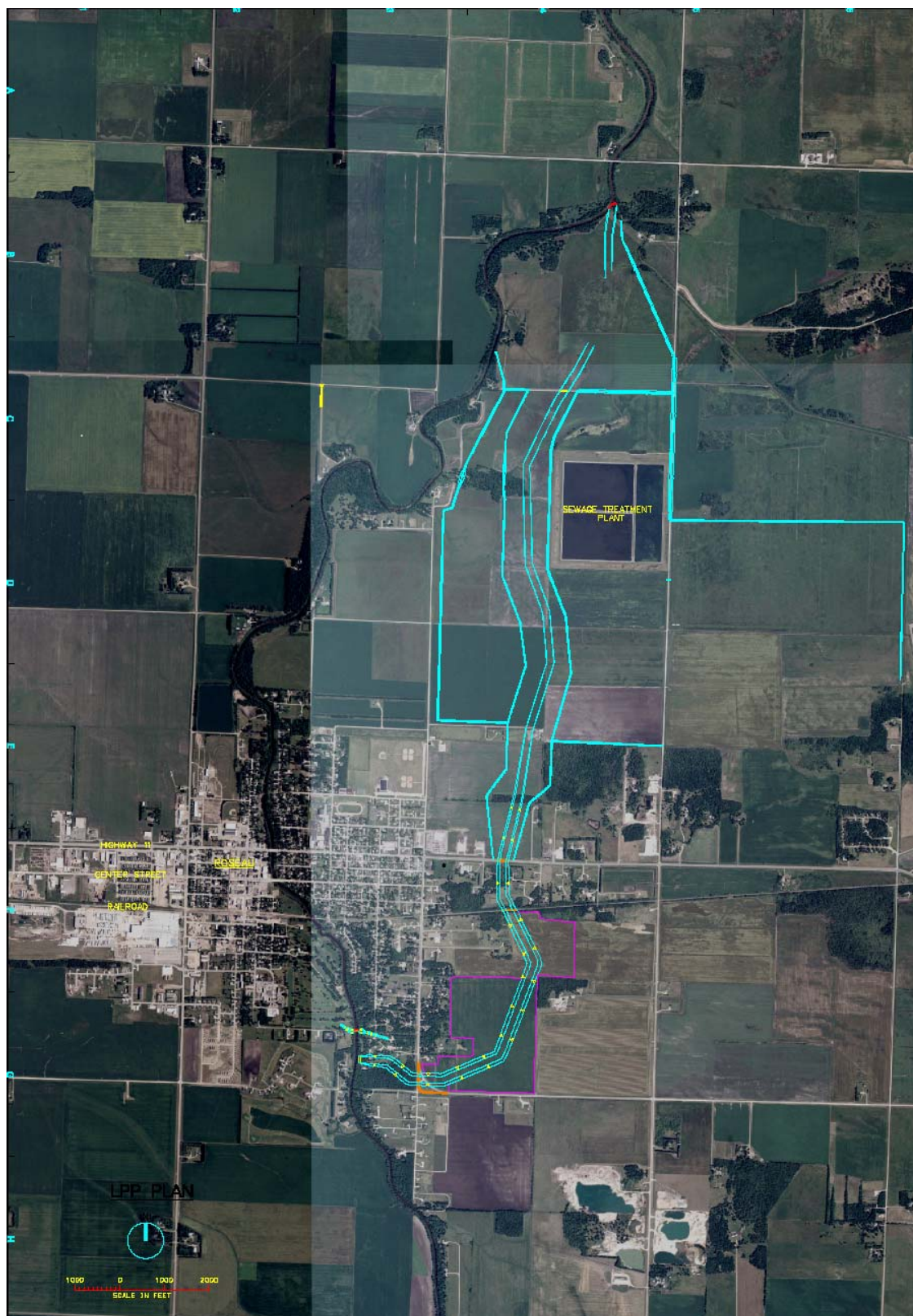


Figure 4 –Locally Preferred Plan East Diversion Channel Alignments and Associated Features

Roseau Flood Reduction Project-East Diversion

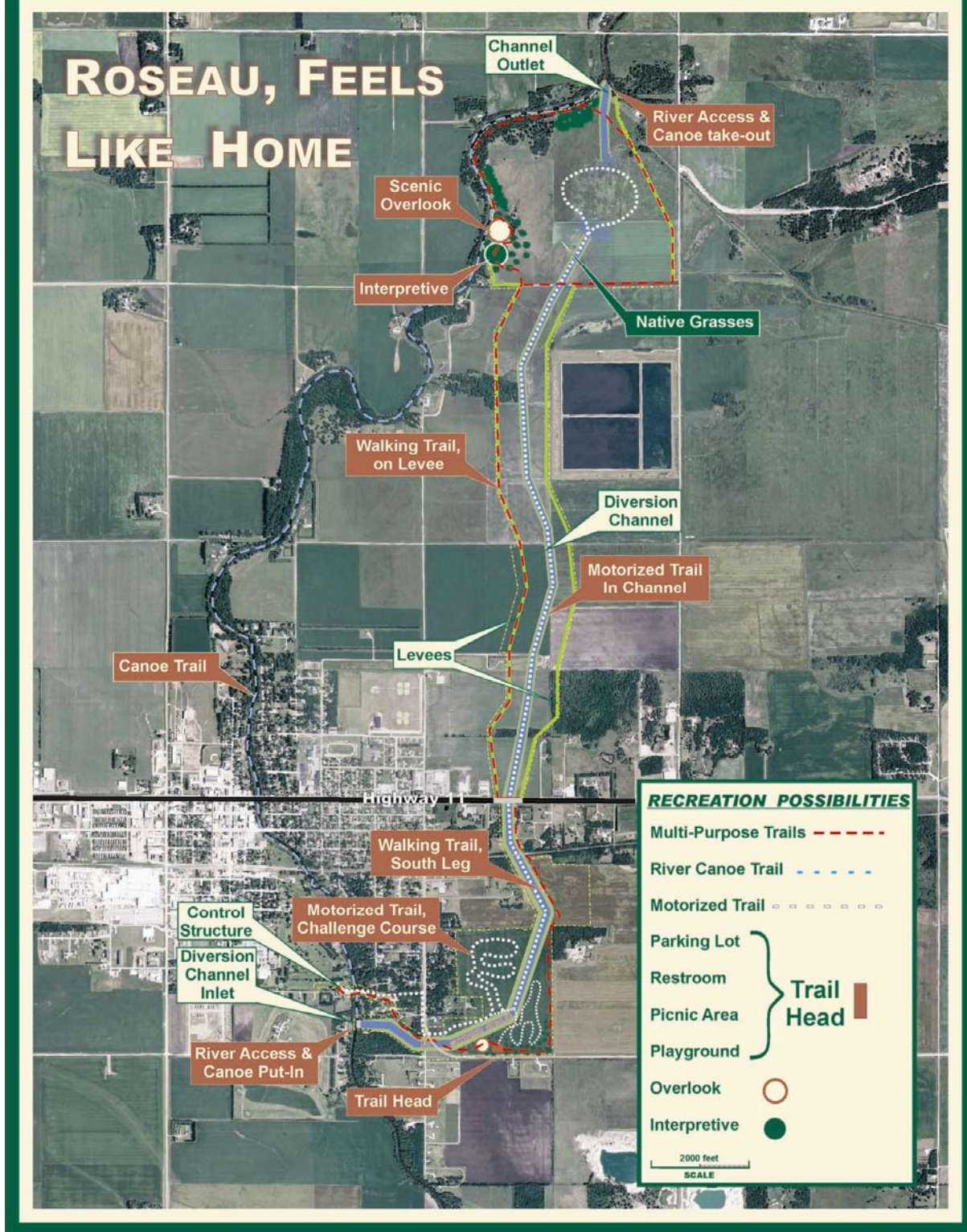


Figure 5 – Proposed Recreational Alignments and Features

Final Benefits and Costs

A detailed evaluation of expected future without-project flood damages has been completed. Flood damage reduction benefits associated with the array of alternatives screened in this plan formulation also have been calculated (see the economics appendix (Appendix C) for additional details). The most detailed economic evaluations conducted as part of this study were used to define the flood damage reduction benefits and costs associated with the optimized east diversion plan.

Table 6. Itemized project costs (December 2004 price level)

Project Feature	Total NED	Total LPP	Difference
Lands and Damages	\$2,000,000	\$3,932,500	\$1,932,500
Relocations			
Other Relocations	\$3,448,200	\$3,448,200	\$0
Railroad Bridge	\$986,080	\$986,080	\$0
Sub Total	\$4,434,280	\$4,434,280	\$0
Channels and Canals			
Diversion Channel	\$4,295,900	\$4,295,900	\$0
Restriction Structure	\$618,300	\$618,300	\$0
CR 28 Road Raise	\$0	\$337,400	\$337,400
Box Culverts	\$0	\$287,800	\$287,800
Spoil Piles Downstream Hwy 11	\$204,300	\$0	-\$204,300
Spoil Piles Upstream Hwy 11	\$2,320,500	\$2,320,500	\$0
Lower Driveway	\$13,400	\$13,400	\$0
East and West control structure (gated culverts)	\$177,500	\$177,500	\$0
Native Plantings	\$275,000	\$275,000	\$0
Sub Total	\$7,904,900	\$8,325,800	\$420,900
Levees and Floodwalls			
West Levee	\$0	\$569,100	\$569,100
Diversion Levee - West Storage Levee	\$543,800	\$239,600	-\$304,200
West Levee Road Raise	\$37,000	\$22,500	-\$14,500
East Levee	\$0	\$589,900	\$589,900
Diversion Levee - East Storage Levee	\$806,300	\$312,400	-\$493,900
East Levee Road Raise	\$208,200	\$144,900	-\$63,300
Sub Total	\$1,595,300	\$1,878,400	\$283,100
PED	\$2,741,300	\$2,868,000	\$126,700
Construction Management	\$1,225,900	\$1,282,600	\$56,700
Recreation	\$1,294,800	\$1,294,800	\$0

TOTAL

\$21,196,480 \$24,016,380 \$2,819,900

A detailed cost estimate, referred to as a baseline or MCACES cost estimate, was prepared as part of finalization of this study to accurately define the project costs for both the NED and LPP. These baseline MCACES estimates include contingencies and present overall project costs that are not expected to deviate significantly from actual implementation costs. The NED and LPP have a number of differences; it is the non-Federal sponsor's responsibility to pay for the overall project increment between those plans. Table 6 shows the breakout of the cost differences by line item, with subtotals per category. It is important to note that there are some slight differences in the features and that the levees providing the 100- year level of protection are referred to as the east and west levee in both plans. The resulting difference of \$2,819,900 was indexed up to October 2005 price levels resulting in a local responsibility of \$2,861,000, which will be used for cost sharing purposes.

Based on the MCACES cost engineering, the estimated total costs of the multipurpose NED plan and the LPP, in October 2005 dollars, are \$21,556,000 and \$24,417,000, respectively. This amount is the project total first cost for flood damage reduction and recreation; it does not include interest during construction and operation and maintenance costs that are used for economic feasibility determinations.

With an anticipated 2-year construction time frame, the cost estimate must account for higher inflated future construction costs expected when the project would be built. Accordingly, the project costs have been inflated to arrive at a "fully funded" construction cost of \$22,707,000 for the NED plan and \$25,700,000 for the LPP (this estimate assumes project construction would begin late in 2007 and would be completed in approximately 2 years; it is used for cost sharing purposes). A summary of the fully funded/adjusted total construction costs to implement all cost features of the NED and LPP is shown in the cost engineering appendix (Appendix D).

The average annual benefits associated with both the recommended LPP and NED plan for flood damage reduction would be \$2,265,300. This estimate represents an 85.7-percent reduction in flood damages for the city of Roseau. With this calculated reduction in flood damages, the NED plan would have a benefit-cost ratio of 1.86 and the LPP would have a benefit-cost ratio of 1.63 for the flood damage reduction portion of the project. The average annual benefits associated with recreation would be \$2,074,900 with a benefit-cost ratio of 18.79 for both the NED plan and LPP. This high benefit-cost ratio is primarily a result of the small costs of constructing the recreational features. The benefit-cost ratio for the combined flood damage reduction and recreation project is higher than the 1.0 benefit-cost ratio required to show a Federal interest in constructing the recommended project. See table 6 for a comparison between the NED and LPP.

A detailed summary of average annual costs and benefits for the NED and recommended LPP permanent diversion channel flood damage reduction plan and associated recreational features is presented in table 8 (see the economics-social-financial appendix (Appendix C) for technical information regarding the benefits analysis).

Designs will be refined during the plans and specifications phase to work with landowners and city officials to reduce project costs where possible and to minimize the social effects wherever practical. After additional topography and soils data are available, the study team will work closely with the affected landowners and the city officials to minimize the social effects and reduce overall/net project costs.

PRELIMINARY PROJECT MANAGEMENT PLAN (PMP)

Recommended Plan Cost Allocations

Based on current cost-sharing provisions, with the proposed plan as an example, Federal and non-Federal costs will be distributed as shown in table 7. A breakout of costs by function is displayed in table 8. The total estimated project cost is the fully funded amount plus contingencies and would be adjusted to reflect actual costs as the project is implemented.

Table 7 – Cost Distribution Proposed Plan

Total Project Cost Estimate	<u>\$ 24,417,000</u>
Lands & Damages	
Federal	\$ 101,000
Non-Federal	\$ 3,883,000
Relocations Including PED & CM	
Federal	\$ 955,000
Non-Federal	\$ 4,466,000
Channels & Canals	
Federal	\$ 7,655,000
Non-Federal	\$ 780,000
Levees & Floodwalls	
Federal	\$ 1,545,000
Non-Federal	\$ 358,000
Recreation Facilities Including PED & CM	
Federal	\$ 830,500
Non-Federal	\$ 830,500
Planning Engineering & Design	
Federal	\$ 1,464,000
Non-Federal	\$ 619,000
Construction Management	
Federal	\$ 835,000
Non-Federal	\$ 96,000

Table 8 – Cost Distribution by Project Type and Feature

Roseau Flood Damage Reduction Project Breakout of Costs Locally Preferred Plan Costs & Benefits			
	Flood Control	Recreation	Total
Project Cost	\$23,929,720	\$1,746,670	\$25,676,390
Total First Costs	\$22,756,000	\$1,661,000	\$24,417,000
Interest During Construction	\$1,173,720	\$85,670	\$1,259,390
Annualized first Costs	\$1,336,189	\$97,531	\$1,433,720
Annual O&M costs	\$54,998	\$12,828	\$67,826
Total Annual Benefits	\$2,265,300	\$2,074,900	\$4,340,200
Net Annual Benefits	\$874,100	\$1,964,500	\$2,838,600
B/C Ratio	1.63	18.79	2.89
Residual Annual Flood damages	\$312,810		

Roseau Flood Damage Reduction Project Breakout of Costs National Economic Development Plan Costs & Benefits			
	Flood Control	Recreation	Total
Project Cost	\$20,921,150	\$1,746,670	\$22,667,820
Total First Costs	\$19,895,000	\$1,661,000	\$21,556,000
Interest During Construction	\$1,026,150	\$85,670	\$1,111,820
Annualized first Costs	\$1,168,197	\$97,531	\$1,265,728
Annual O&M costs	\$52,750	\$12,828	\$65,578
Total Annual Benefits	\$2,265,300	\$2,074,900	\$4,340,200
Net Annual Benefits	\$1,044,400	\$1,964,500	\$3,008,900
B/C Ratio	1.86	18.79	3.26
Residual Annual Flood damages	\$312,810		

Assumes 5 1/8 percent interest rate over a 50-year period of analysis

On the basis of the provisions of Section 103 of Public Law 99-662, the city of Roseau does not qualify for a reduction in its cash contribution. The analysis, illustrated in table C-F-2 of the economics appendix (Appendix C), is based on the proposed plan benefit-cost ratio and the project area per capita income.

Preliminary Financial Analysis

During the preconstruction engineering and design phase, prior to the signing of the project cooperation agreement (PCA), a District Commander's assessment of the non-Federal sponsor's financial capability will be produced to determine if it is reasonable to expect that ample funds will be available to satisfy the non-Federal sponsor's financial obligations for the project.

Factors that would affect the city's ability to meet the obligations of the non-Federal sponsor include the number of projects competing for capital improvement projects (CIP) funds, bond rating, current indebtedness, and anticipated indebtedness. No other major capital projects that would require significant financing are anticipated at this time. In addition, the State of Minnesota has committed considerable financial assistance for the proposed project.

On the basis of current information (see the economics appendix (Appendix C) for more information), the city has the willingness and capability to finance its share of the cost of constructing this local flood protection project. The city is ready, willing, and able to fulfill all the responsibilities required to serve as the non-Federal sponsor for this project, including obtaining the necessary real estate interests, providing the required cost shared funds, and operating and maintaining the project upon completion.

Construction Staging and Schedule

Key Planning and Construction Phasing Assumptions:

- | | |
|--|--------------|
| 1. Enter into a design PED agreement and begin PED | August 2006 |
| 2. Complete PED | July 2007 |
| 3. Enter into PCA agreement | October 2007 |
| 4. Begin construction | April 2008 |
| a. The first construction contract would be for construction of the two highway bridges; funds would be provided by the local sponsor. | |

- b. The second contract would be for construction of the railroad bridge.
- c. The third construction contract would be for the diversion channel and associated features.
- d. The fourth construction contract would be for construction of levees being used for temporary ponding.
- e. The fifth contract would be to construct the restriction structure.
- f. The remaining construction phases would be for recreational and related features and any remaining work that needs to be performed for the functionality of the designed project.

5. Complete construction

October 2009

Operation and Maintenance Requirements

Local interests would operate and maintain the project in accordance with the procedures and schedules set forth in an operation and maintenance manual that the Corps of Engineers would prepare and provide. The total estimated annual cost of operation and maintenance for the flood damage reduction portion of the LPP would be \$54,998; the estimated annual cost for the operation and maintenance for the recreation portions would be \$12,828. The local sponsor is responsible for repair, rehabilitation, and replacement of all project features. Maintenance would consist of periodic inspections of and repairs to the diversion channel, bridges, restriction structure, recreational facilities, and other associated project features.

Study Participants and Public Involvement and Approval Process

Interagency and Public Coordination

An experienced and diverse interdisciplinary study team composed of Corps of Engineers personnel and non-Federal sponsor representatives have been heavily involved on a regular basis in the preparation and coordination of this study. Many other local, State, and Federal officials and individual citizens have also had an opportunity to provide important ideas or inputs into some aspect of the inventory, analysis, or formulation of the plans presented in this report.

Efforts to maintain good communications between potential project sponsors and stakeholders were fostered through structured partnering workshops and meetings conducted at key points in the formulation of plans associated with the Federal flood damage reduction feasibility study in Roseau.

The following meetings were held:

- April 29, 2004, Roseau. Interagency scoping meeting was used to present information regarding the Roseau flood damage reduction feasibility study.
- April 29, 2004, Roseau. Public scoping meeting used to present information to the general public and to gain additional input.
- April 13, 2005, Roseau. Environmental coordination meeting. This meeting was used to present the selected east diversion plan.
- April 13, 2005, Roseau. Landowners meeting. This meeting was used to present the selected plan to those landowners who would most likely be affected by the proposed project. Letters were sent to landowners notifying them of the meeting.
- April 14, 2005, Roseau. Flood control task force meeting was used to present the selected plan to the task force.
- April 14, 2005, Roseau. Public open house meeting to present the selected east diversion plan to the general public.
- June 2, 2005, Roseau. Spruce Township/public meeting. This meeting was to address concerns raised by the citizens of Spruce Township and other public questions.

In addition to the public meetings, two newsletters were published, the first in March 2004 and the second in June 2005. These newsletters along with the webpage www.mvp.usace.army.mil/roseau served as conduits of information for the public and agency representatives. The local media also provided coverage of the project, and a number of stories/articles were presented via local radio and newspaper.

Coordination with the city of Roseau, the Roseau River Watershed District, and the State of Minnesota has been ongoing throughout the planning process. Representatives from the city have been present at each of the study team meetings to provide their ideas regarding possible flood damage reduction actions and to follow the progress of the study.

In June 2006, the draft feasibility report and environmental assessment will be distributed to interested agencies, local units of government, and the public for review and comment during a 30-day review period. A public workshop/meeting will be scheduled during this time to obtain comments from the public on the evaluation of the proposed plan.

The final report is scheduled to be submitted to Corps of Engineers Headquarters in July 2006. The feasibility report is a “decision document” that will receive interagency comment and will be transmitted by the St. Paul District Commander to the Division Commander and on to the Chief of Engineers in Washington, D.C., for formal approval.

See the environmental assessment (Appendix E) for scoping related views and comments received from citizens and interested agencies.

Higher Corps Authority Review and Approvals

The draft report was distributed on a limited basis and was submitted for Independent Technical Review (ITR) to the Rock Island District, and an Alternative Formulations Briefing (AFB) review with higher authority to review, comment, and approve the release of the draft report for public and interagency review took place in March 2006. It is anticipated that public and interagency review will take place in June 2006.

Inventory, Analysis, and Study Findings

This section of the report presents a brief summary of the key technical procedures and considerations associated with the plan formulation and recommended plan/project design. The information is presented by functional discipline (Note: For more detailed technical data and analysis, see the technical appendixes section to this report).

Hydrology

The hydrologic analyses were done to develop the discharge-frequency relationships for the Roseau River. Discharge-frequency relationships were developed for two locations on the Roseau River at the U.S. Geological Survey (USGS) gages at Malung upstream of Roseau and at Ross, Minnesota, the most downstream gage located within the study area. Discharge-frequency relationships were also completed for the Roseau Center Street gage. Statistical analyses were accomplished using Corps of Engineers computer program HEC-FFA “Flood Frequency Analysis,” which incorporates techniques consistent with Bulletin 17B “Guidelines for Determining Flood Flow Frequency Analysis.” Statistical computations for this analysis were based on annual instantaneous peak discharge values and the computed probability with no expected probability adjustment. Methodology used for this report is in accordance with the general guidelines for hydrologic analyses for flood insurance studies. The updated statistical analyses presented in this report use period of record data including peak flows and elevations for the 2002 flood. The 2002 flood devastated the community of Roseau and had an instantaneous peak discharge more than twice the magnitude of the previous maximum flood of record.

Detailed discussions of the hydrologic methods used along with the derived frequency relationships are provided in the hydrology appendix (Appendix A).

Hydraulics

Hydraulic analysis performed for this study included determining diversion channel configurations that would meet hydraulic and geotechnical requirements, top-of-levee profiles using risk and uncertainty analysis, analysis of upstream and downstream project impacts, and addressing overland flow conditions. Detailed discussions of the hydraulic analysis are provided in the hydraulic design appendix (Appendix B).

Hydraulic modeling was accomplished using the HEC-RAS model. This model was used for both steady state and unsteady state modeling conditions. The HEC-RAS modeling includes the Roseau River from its confluence with Bear Creek to the town of Ross. The South Branch Roseau River was modeled from County Highway 129 to its confluence with the Roseau River at Malung. Sucker Creek was modeled from County Road 21 to its mouth on the South Branch Roseau River.

The proposed east diversion project consists of a diversion channel, storage cells surrounded by levees, a restriction bridge, and breakout flows. The HEC-FDA program was used to produce levee heights that would give a 95-percent level of confidence that the levees bounding the diversion channel would not be overtopped by the 1-percent-chance (100-year) flood.

The non-Federal sponsor requested that additional storage ponding areas be added to eliminate changes in stages downstream of the project. Without the additional storage, peak stages for a 100-year flood could increase 0.1 foot. The additional storage ponding areas have been added to the proposed plan to counteract this effect. Storage areas have been identified on both sides of the 1,000-foot-wide east diversion corridor. These storage ponding areas are leveed farm fields that are isolated from the diversion channel by an additional set of intermediate “storage levees.” The storage levees would keep the fields dry for all but the large floods. During large floods, the peak discharges, beginning with the 20-year event, would reach the height of an earthen spillway at the upstream end of the storage levee. This water would collect on the levee-bound fields until river stages have receded enough that the water could be released, effectively eliminating any induced effects downstream.

A restriction bridge has been added to increase the efficiency of the east diversion channel. This bridge would increase the energy available to drive water through the diversion channel, better using the diversion channel. The restriction bridge would be located on the main Roseau River channel just below the inlet to the diversion channel.

The east diversion alternative would reduce stages in the main channel of the Roseau River. It was determined this change would have an adverse effect on the flow distribution and breakout flows in one location. At this location, a driveway acts as a weir, controlling breakout flows from the west bank north of town. To eliminate this adverse effect, the driveway elevation would have to be lowered 0.6 foot for the 150-foot bottom width east diversion channel to maintain the existing breakout.

Interior Flood Control

This project has no interior flood control features; however, the city of Roseau and the Roseau County Watershed District are developing plans to address any interior flood control issues that may be present in the area. A summary of potential projects follows:

Outside the City

The west side intercept project, which is being designed by the watershed district, will divert overland water coming from the west of the city north to the old Roseau Lake bottom. This intercept ditch will capture drainage from 1 mile west and out before it enters the city. The city anticipates that this project will be completed by fall 2006; it is not part of the proposed plan.

In the City

The city is connecting the west side storm water system and diverting it into a large storm water basin. A pump station will be placed at the basin to provide continuous operation of the west side storm water system. This project is under construction and is slated for completion in summer 2006.

On the east side, certain portions of the plans are under construction. The project consists of tying three of the existing major storm sewer outlets together and eventually tying them into a new storm sewer main that would be directed to a basin north of town. Currently, during flooding, the storm outlets are plugged and pumped with large portable pumps, which were purchased after the 2002 flood. It is anticipated that those pumps will continue to be used as needed.

Geotechnical Design and Geology

Geology

The geology influencing the Roseau River watershed is the legacy of glacial Lake Agassiz and recent fluvial/alluvial processes of the river and its tributaries. During the glacial period, a continental glacier covered the entire watershed. Periodically, as the glacial ice melted and retreated northward, huge ice dams were formed, which blocked the natural northerly drainage pattern. Glacial Lake Agassiz, which covered approximately 200,000 square miles, resulted from the ice damming and subsequent ponding of melt waters. The lake is believed to have existed from approximately 13,800 to 9,000 years ago during the Late Wisconsin Glacial Episode of the Pleistocene Epoch. As the glacier receded and advanced, fluctuations of the lake levels resulted in corresponding variations of the sediment types. After the glacial lake drained for the final time, the relatively youthful drainage pattern of the present Roseau River watershed established itself on top of the lake sediments. A useful

analogy may be to consider the river course to be little more than a scratch in a broad tabletop.

Site Hydrogeology

The generally low permeability of the soils within the proposed project boundaries makes determination and prediction of groundwater levels challenging. Occasionally, some fluvial seams near the river are sufficiently pervious to allow a confident measurement; however, these limited data do not yield much useful information about the interaction between the river water surface and the overbank groundwater conditions.

Groundwater levels in the Roseau area are high. Soil borings and cone penetrometer testing taken for this study revealed groundwater to be 7 to 15 feet below the ground surface level. Indications from one piezometer show that the groundwater level corresponds approximately to the river water surface elevation.

Geotechnical Design

General

The geotechnical design for this report was based on experience in the Red River Valley. Special consideration will be taken on the construction of the levees to eliminate cracking, similar to approaches used in other regions of the Red River Valley. Further geotechnical analysis will be done during the plans and specifications phase following the retrieval of boring samples in the areas of the diversion channel, restriction structure, spoil piles, and bridges.

Subsurface Investigations and Laboratory Testing

In support of the geotechnical design process, the Corps has a record of 12 soil borings that have been drilled in Roseau since 1999. Five borings were obtained by Midwest Testing Laboratory, three by Braun Intertec, and four by Interstate Drilling Services to provide information for an interior flood control ponding area that was designed by Barr Engineering as well as for this study.

Laboratory test data from samples obtained by soil boring operations are shown on Geotechnical Plates G-27 through G-32.

Credit to Existing Levees

Roseau is currently protected by a system of temporary or emergency levees lining both sides of the Roseau River as it runs through town. The temporary levees were analyzed to determine a baseline level of protection that the existing levees provide to the town. To determine the potential for failure, other than by overtopping, of the existing levee system, a risk-based analysis of levee reliability has been performed in accordance with Policy Guidance Letter No. 26, ER 1105-2-100, and Appendixes A and B of ETL 1110-2-556.

Slope stability was the failure mode considered in this reliability analysis. See the geotechnical appendix (pages G-12 through G-15) for details on each of the temporary levees analyzed.

Design Criteria

EM 1110-2-1913, "Design and Construction of Levees," was used for guidance in analyzing slope stability for this report. The computer program SLOPE/W was used to perform slope stability calculations. Spencer's method was used for all analyses. The two conditions that were analyzed for this report included the end-of-construction case and the long-term case.

Future Work

Additional geotechnical analysis will be required in the plans and specifications phase of this project. Work will include further geotechnical evaluations of slope stability, settlement analysis, bearing capacity, shear strength, permeability, compressibility parameters, setback distances for spoil piles and levees, riprap gradations, and evaluating borrow sources, based on additional boring information.

Sources of Construction Materials

Borrow Sites

The non-Federal sponsor is responsible for identifying sites to be used as borrow sources. Geotechnical and archeological investigations have not been completed on any sites to date. These studies, if needed, will be done prior to completion of the plans and specifications phase of the proposed project. Geotechnical parameters to be defined prior to approval of those sites include the thickness of topsoil, thickness and suitability of alluvial/fluvial soils, water bearing seams and water table conditions, natural moisture content, and Procter density.

Disposal Sites

No hazardous material disposal sites are anticipated for this project. Any contaminated materials uncovered as a result of the project construction would need to be disposed of in accordance with Federal and State criteria/requirements and laws.

Concrete Aggregate, Riprap, and Bedding

Sources for fine and coarse concrete aggregate, bedding, and riprap should be available locally. Most commercial aggregates in the vicinity are obtained from the beach ridges of glacial Lake Agassiz. Additional material may be available from field stone piles in farm fields. Most of the material consists of rounded, wave-washed boulders, cobbles, and sand. If large quantities of riprap size material are required, producers will need adequate lead-time to stockpile material. Outside sources of quarried, angular stone should also be available approximately 200 miles east or south of the proposed project in western and

central Minnesota. Additional investigations will be necessary prior to the plans and specifications phase to accurately quantify the amount of stone product available within a reasonable radius of the area.

HTRW Site Investigations

A Phase 1 Assessment (ESA) was conducted under contract in spring 2005. The report is available as a standalone document. The assessment concluded that additional investigations might be necessary if levees are constructed in the city proper. If the diversion alternative as currently proposed as the recommended plan is the selected alternative, a minor effort to complete a final update will be necessary and will be completed in the plans and specifications phase.

Economic – Social – Financial

Economics

The economics analysis describes the socioeconomic environment and presents the results of an economic evaluation of the flood threat from the Roseau River at Roseau. The evaluations are based on overbank flood profiles projected within the city. Expected flood damages to the residential, commercial, and public sectors of Roseau are considered for existing conditions and with proposed flood damage reduction measures in place using the risk and uncertainty guidance.

The city occupies an area of approximately 170 acres. The Roseau River flows in a northerly direction through the city. The portion of the city located on the east side of the river is primarily residential; whereas the portion of the city located on the west side of the river includes the business district, municipal government buildings, hospital, residential areas, and the Polaris Industries manufacturing facilities. Most of the city is located in the regulatory floodplain because the city is very flat; therefore, once the river flows out of its banks, it flows throughout almost the entire city.

The St. Paul District has completed this feasibility report and associated environmental assessment as a formal decision document. This report is intended to document plan formulation studies conducted by the St. Paul District in cooperation with the city of Roseau.

The purpose of this report has been to collect and evaluate information about current conditions to define a feasible and implementable Federal local flood damage reduction project that would provide permanent protection for Roseau. To accomplish this, an array of possible alternative plans were considered for remedial action within the study area.

It was determined that the east diversion plan was the selected plan, and further optimization analyses were completed to determine the NED plan. Three different bottom width sizes of the plan were analyzed: 50, 150, and 350 feet. The NED plan is the 150-foot bottom width east diversion channel.

Close coordination was done with the non-Federal sponsor. The city supported the inclusion of recreation components and formally requested the addition of storage areas to the recommended plan.

The project features are designed to reliably contain a 100-year flood with minimal residual damages. The recommended LPP would reduce damages by 86 percent and provide a strong framework for the non-Federal sponsor to fight the larger, rarer events when they occur.

The proposed project would have average annual flood control benefits of \$2,265,300 and an average annual flood damage reduction cost of \$1,391,200. Net benefits would be \$874,100 and the resultant benefit-cost ratio for the flood damage reduction portion of the project is 1.63. The project is economically justified. Annual recreation costs would be \$110,400 with annual recreation benefits of \$2,074,900 for a recreation feature benefit-cost ratio of 18.8. For more information on the development of costs and benefits see the economic appendix (Appendix C).

Social / Financial

Roseau is the county seat for Roseau County and serves as a strong retail trade center for the region. With a 2000 population of 2,756, Roseau is the largest city in Roseau County, accounting for 16.9 percent of the county's population with a market area of over 60 miles. This market area encompasses all of Roseau County and Lake of the Woods County and portions of Marshall, Kittson, Pennington, and Beltrami Counties in Minnesota and a portion of southeastern Manitoba, Canada. Manufacturing and agriculture are the dominant industries in the area, and Roseau is supported by Polaris Industries, Inc., which employs more than 2,100.

The recommended project is socially acceptable to the public and the non-Federal sponsor. Significant effort has been made to avoid the taking of any homesteads and to satisfy public concerns whenever possible. The recreation portions of the project have been met with significant support and will be a valuable resource for the Roseau area for years to come.

It has been determined that the city, with assistance from the State of Minnesota, is capable of financing its portion of the construction costs and the operation and maintenance costs associated with the project. The city has indicated that it will be able to issue general obligation and/or special assessment revenue bonds to fund the project.

Recreation and Aesthetics

Recreation

Roseau is small town, “Heartland” America, with quiet residential streets bordered by large trees and the Roseau River winding through it and running adjacent to the downtown business section. Roseau's small town persona is retained within its friendly, industrious people, physical environment, and location—the Midwest agricultural belt. Roseau experienced a 15-percent population growth in the 1990's; this growth can be partially attributed to its diversified economy. As a relatively isolated urban outpost, the city has few passive or family-oriented recreation resources.

Adding recreation amenities to the flood damage reduction features would greatly increase the usability of the project by opening project lands to full-time, year around use by the general public. The project has the capability to provide significant recreation opportunities to a community and region that has few passive recreation assets and, more importantly, it would be located in an area that would benefit many of the region's residents. The Roseau City Council has endorsed adding a recreation component to the project, and the public has approved the draft recreation concept.

Existing Recreation

With a population of 2,800, Roseau is the largest city in the county and serves a five-county region with 76,000 people. The existing recreation facilities in the city of Roseau are:

- Roseau City Park, 37 acres, includes a small playground, restrooms, showers, picnic facilities, open space, parking, a MnDNR boat ramp, recreational vehicle (RV) camping spaces with water and electrical hook-ups, and tent sites. The park provides views and access to the Roseau River adjacent to the west. It is bounded by a county highway to the east, an established neighborhood to the north, and a 15-acre woodland to the south, next to the campground. A developing housing area is immediately to the south of the woodland.
- North Star, or Bjorkman Park, is located in the southwest part of town and provides quiet green space for neighborhood residents.
- Westside Park provides a playground and basketball courts for users.
- Mothers Park provides quiet green space and flower gardens for the neighborhood.
- The small Veterans Memorial Park serves the downtown, providing open green space, views of the river, and a veteran's memorial.

- Several indoor arenas provide playing areas and spectator facilities for team sports events, especially ice hockey.
- Fishing on the river. Anglers on the Roseau River commonly catch walleye, sauger, northern pike, freshwater drum, and catfish, but public access to the river is limited and difficult.

Two State parks and two State forests are in the region. The area in general is lacking in State or national hiking trails, although it has some local trails. The area has a loose network of snowmobile trails and no dedicated trails for all-terrain vehicles. The regional recreation resources are listed below:

- Beltrami Island State Forest covers 66,903 acres in Roseau, Lake of the Woods, and Beltrami Counties. The area provides canoeing, camping, fishing, hunting, hiking, horseback riding trails, picnicking, cross-country skiing trails and 120 miles of snowmobile trails.
- Hayes Lake State Park is located 18 miles southeast of Roseau. Consisting of 3,000 acres of pines, lakes, and wildlife activity, the park is open year-round for visitor use. Activities include camping, swimming, picnicking, hiking, biking, horseback riding, canoeing, and fishing. In the winter, the park features snowmobiling and cross-country skiing with 12 miles of groomed trails (6 miles for cross-country skiing and 6 miles for snowmobiling). The park trails connect to hundreds of miles of snowmobile trails in the adjacent Beltrami Island State Forest.
- Zippel Bay State Park, 40-miles east on Lake of the Woods, has camping, a beach, winter recreation, and fishing.
- Lost River State Forest, 7 miles to the northeast, is 63,000 acres of unimproved wilderness forest.

Project Recreation

Project recreation design will provide four-season recreation features and amenities for the community and its visitors. Preliminary recreation design uses project flood damage reduction features: the diversion channel, the levees, the floodwater storage areas, and even the spoil for outdoor recreation purposes. All recreation design for the project will meet the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas under the American with Disabilities Act of 1990 (ADA). Proposed recreation includes:

- Pedestrian/bicycle trails.
- Interpretive wildlife trails.
- Recreation vehicle trails.
- River canoe trail.

- Improved river access.
- Fishing pier.
- Parking for recreation users.
- One trailhead.
- Picnic areas.
- Restrooms.
- Scenic overlooks.
-
- Interpretive trails with overlooks.
- Birding stations.

Individual Recreational Aspects and Aesthetics

Multipurpose Trails

Three-pedestrian/bicycle multipurpose (MP) trail loops would be constructed with a combined length of about 7-miles. The MP trails would be 8 feet wide, made of compacted gravel or asphalt, and situated on the west bank of the diversion channel then crossing over to the east side of the diversion traveling north and looping back down to the west bank. This feature has been designed as an interlocking trail system that would provide varying distances and experiences to the users. The south trail would be a 2-mile segment from the river structure to Highway 11 and would have an asphalt surface. A high overlook would illuminate the entire project on this leg. The north trail would be a 2½-mile elevated prairie trail sited on the levee, extending from Highway 11 to the river north of town. A 2½-mile wildlife interpretive trail loop would connect to the north trail and wind along the river to the channel outlet, tying into the easternmost levee and connecting back to the main trail, winding through areas containing plantings of trees and native species of groundcover. The wildlife trail's riverbank segment would provide scenic overlooks, interpretive areas, and birding stations. The north and south loops (main trail), using the project control structure as a river crossing on the south end and the project levee on the north, would connect to existing or planned urban trail segments constructed by the city, which are located on the west side of the river.

Canoe

The canoe trail would connect the upstream and downstream ends of the project. It would consist of two small gravel parking lots, two launch structures, two retrieval structures, and a short portage trail provided by the city. This recreation trail would have a north segment of about 1.5 miles and a south segment of about 3 miles with parking at either end. These segments would connect via a short portage in town, which is necessitated by the dam.

Off-Road Vehicle Trails

Two 12-foot-wide, compacted off-road vehicle trails are also planned. They would be suitable for all-terrain vehicles, dirt bikes, motocross, and snowmobiles and would function all year. For safety, they would be physically separated from multipurpose trails.

Innovative use of spoil would allow the trail design to incorporate challenges and difficulties into trail topography that are not usually available in the flat terrain of this region. Several local clubs would be enlisted to help with trail design. It is understood that they would “adopt” these trails for maintenance and regulatory duties after construction, but overall operations and maintenance would be the city’s responsibility. Support facilities for the off-road vehicle trails include a trailhead east of the city park. Restrooms, potable water, picnic facilities, and parking are planned for the trailhead. This trail would be ideal for winter recreation use by area snowmobilers and is about 9 miles long.

Recreation Benefits

Market area

Roseau’s location in rural northern Minnesota provides difficulty when computing the market area. Nearly 50 percent of the recreation study area lies in Canada and is further limited by Lake of the Woods, which is 70 miles across and a mere 20 miles from Roseau. The study assumes the area of influence to be the five counties closest to the city of Roseau. These five counties have a population of about 76,000, with the majority being located in very small rural towns.

Through significant consideration, it was determined that the market area for the project-supported recreation would be defined as those areas accessible within a 1-hour drive of the project, except for areas in Canada. Even though Canada is being excluded from consideration, Canadian visitors would certainly affect actual usage rates for the proposed recreation in Roseau.

Unit-Day Values/Benefit-Cost

Unit-day values were developed for each recreational activity. This methodology relies on professional judgment to assign point values to five specific criteria:

- Recreation experience—pertains to the availability and quality of activities on site.
- Availability of opportunity—is specific to travel times and scarcity of activities.
- Carrying capacity—concerns the level of site recreation development.
- Accessibility—pertains to the ease of access, specifically by automobile.

- Environmental—is specific to the aesthetic qualities of the site and surrounding areas.

The total points assigned are converted to a unit-day value, which is then applied to the estimated visitation to derive the overall benefits (see the recreation appendix (Appendix I)).

Annual recreation benefits were derived from estimated project demand for the recreational activity and unit-day values. The benefits under each of the measured categories were computed on an annual basis and resulted in \$2,074,900 in benefits annually. The annual cost for the recreation features has been determined to be \$110,400 resulting in a benefit-cost ratio of 18.79.

Structures

Structural features associated with this project include a railroad bridge, two highway bridges, a box culvert structure, a restriction and bridge structure, and miscellaneous drainage structures.

The primary objective of this effort was to determine feasibility of designs and establish reasonable quantities for the baseline cost estimate. The level of design was conducted to sufficient detail to attain these objectives. The design of structural features followed governing Corps-wide criteria as follows: EM 1110-2-2104, Strength Design for Reinforced Concrete Hydraulic Structures; EM 1110-2-2502, Retaining and Floodwalls; EM 1110-2-2902, Conduits, Culverts and Pipes; EM 1110-1-2101, Working Stresses for Structural Design; EM 1110-2-2105, Design of Hydraulic Steel Structures; EM 1110-2-2504, Design of Sheet Pile Walls; ETL 1110-2-256, Sliding Stability for Concrete Structures; ETL 1110-2-307, Flotation Stability Criteria for Concrete Hydraulic Structures; and ETL 1110-2-322, Retaining and Floodwalls.

There are one railroad bridge and two highway bridges: Highway 11 and County Road 124. The bridge's substructure is of reinforced concrete and steel pilings. Bridge superstructure is of precast concrete girders and cast in-place slab. No design of the bridges was created. Approximations of the surface area were completed at this stage to identify quantities and costs.

A box culvert structure would be placed where the diversion channel crosses County Road 28. The structure is composed of five box culverts and a retaining wall on each corner. Each retaining wall would be reinforced concrete. Box culverts installed under the road would be designed according to EM 1110-2-2902, Conduits, Culvert and Pipes and ACPA Concrete Pipe Handbook guidelines. Also, Minnesota Department of Transportation guidelines for box culvert highway design would apply.

A restriction and bridge structure would be used to restrict the river flow, provide access for pedestrians, and provide access to remove debris trapped under the bridge. It would be

composed of a bridge deck supported on girders. The upstream girder would act as a restriction structure; it would be 8 feet deep below the top of the deck. The deck would be reinforced concrete; the girders could be reinforced concrete or precast concrete. The bridge would be supported on abutments. The abutments would be reinforced concrete and steel pilings.

Gravity control structures would be used to control flow of water within the flood-protected areas. The structures would be single-bay reinforced concrete box-shaped structures. Flows would be controlled by sluice gates with aluminum stoplogs as a secondary closure. The control structures would be reinforced concrete founded on reinforced concrete slab. The design of control structure follows criteria provided in EM 1110-2-3104 (for loading conditions and stability criteria), EM 1110-2-2502 (for determining soil loads), and EM 1110-2-2104 (for reinforced concrete design).

Miscellaneous drainage pipes and outlet and inlet pipes would be precast concrete and are assumed to be a Class 4 design. Future designs would follow EM 1110-2-2902 and ACPA Concrete Pipe Handbook guidelines.

Environmental and Cultural

The environmental assessment considers the potential effects of alternatives on the existing conditions of the area, predicting the future conditions that may occur with the project in place. When compared to future conditions without the construction of the project, the effects of project constructions and operation may be determined. See the environmental assessment (Appendix E) for more detailed discussions.

Existing Setting

The project area is located on and near the Roseau River, a tributary of the Red River of the North. Prior to settlement, wetlands and forests were the dominant vegetation types in the Roseau River watershed. As agriculture and the associated wetland drainage developed in the area, however, wetlands decreased by approximately 20 percent with forested areas decreasing as much as 60 percent. The remaining areas of permanent wetlands are concentrated primarily in the northern portions of the county. Many agricultural fields provide temporary flooded wetland habitat during high runoff events, primarily occurring in the spring.

The area surrounding the proposed project area consists of several distinct habitat types. On the south, upstream end, the project begins in the Roseau River valley, which is relatively wide and incised. The upstream end of the diversion channel would pass through the oak/ash/cottonwood-wooded area of a city park. Once out of the park, the next 2 miles of the diversion would pass through agricultural croplands interspersed with residential development and wood lots. As the diversion channel would extend northward, the surrounding area loses elevation and is intermittently farmed or has developed into old-field habitat. The northern end of the proposed project area lies within the river's 10-year floodplain.

The proposed project has a diverse fauna, which is in part a result of the presence of nearby State wildlife management areas and State forests. The Roseau River supports both game and nongame fish species, but diversity, abundance, and geographic occurrence are largely dependent on existing barriers, water quality issues and winterkill caused by low flows. Three federally listed threatened species are in the area: bald eagle, Canada lynx, and gray wolf.

Environmental Effects on Natural Resources

It is anticipated that this project would have minimal adverse effects on the natural resources of the region. Adverse effects, other than those that would be temporary and construction related, would be avoided or minimized. It is not expected that this project would contribute to cumulative effects.

The surface areas needed for the proposed project features are as follows: diversion channel – 112 acres; excavated soil disposal – 120 acres; floodway – 232 acres; east storage area – 853 acres; west storage area – 236 acres; and northern area – 299 acres. Of these areas, disturbance caused by project related construction would be restricted to the diversion channel, soil disposal area, the perimeter of the storage areas where levees would be built, and the outlet channel on the northern end of the project.

Construction impacts on the project area would be minor and short term. These effects would consist of temporary adverse impacts to air quality, terrestrial habitat, some disruption of benthic area and an increase in suspended solids during construction and rock placement. No adverse impacts to threatened and endangered species or the cultural resources in the region are anticipated.

The project alignment has been altered through the planning process to avoid impacts on wetlands. The wetlands in the project area that would be affected are of poor quality and offer minimal habitat value. These wetlands are small and separated by roads or agricultural fields. Effects on wetlands would be more than offset by the project design, which, with the assistance of native and tree plantings, would allow the project lands, currently farm fields, to return to a more natural state.

The proposed action would have overall beneficial impacts on the area's habitat diversity. The rock protection in the river channel would provide diversity of benthic habitat by replacing some of the sandy-clay substrate typical in this portion of the Roseau River. Implementation of the proposed features would also increase diversity in the terrestrial portions of the project area. Land acquisition for the project would return substantial areas to a more natural condition. The diversion channel and portions of the floodway, which had been used for agricultural purposes, would be seeded with native grasses, although it would be mowed to maintain functionality. Within the storage areas, severing existing drains and ditches would allow wetland habitat to redevelop. The open area on the northernmost area of the diversion channel would also be planted with native species or allowed to return to a natural, non-agricultural setting.

Environmental Effects on Cultural Resources

This portion of Minnesota contains numerous cultural resources indicating continual human occupation for approximately 12,000 years. Cultural resource sites within the region exist on a variety of landforms, including uplands, terraces, and glacial beach ridges. Precontact cultural resources include lithic and artifact scatters, burial mounds, and cemeteries. Historic cultural resources include Euro-American structural ruins, standing structures and roads. The general project area has been surveyed during several previous flood control studies of the Roseau River. Although no sites were identified in the area proposed for this project, both pre- and post-contact sites were located in adjacent areas.

A Phase I survey of the proposed project area will be conducted prior to any construction. This survey would include a surface reconnaissance along the proposed levee and channel alignments and associated work and staging areas, deep site testing over archeologically sensitive areas (i.e., floodplain) and shovel testing in other sensitive areas (i.e., terraces, topographic high spots) that would be directly or indirectly affected by earth-moving activities (e.g., levee and channel construction). Any cultural resources sites identified in the project construction limits would be evaluated for eligibility to the National Register of Historic Places. Potential project impacts on eligible properties would be mitigated prior to construction, if said impacts could not be avoided.

Environmental Effects on Sociological Resources

The project would have no long-term adverse impacts on the socioeconomic resources in the project area. The proposed project would not have a disproportionate negative impact on minorities or low-income populations, no residential or business relocations would be needed, and transportation impacts would be limited to construction. In addition, the project would provide a number of benefits to the Roseau area. Public health and safety would have a net benefit because, with a decreased frequency of floods, the risk of loss of life and property would be reduced. The project has the potential to foster community cohesion along with maintaining growth and stability in the Roseau area.

The proposed project would have substantial beneficial effects on public health and safety by considerably reducing the risks of loss of life and property damage attributable to the effects of flooding. In addition, flood protection would minimize the exposure of emergency and clean-up personnel to sewage and other contaminants introduced into the environment during a flood. It could also result in increased levels of community cohesion and enhance further community growth and development by reducing the threat of flooding in the city of Roseau.

The project would not come without conflict. The public has some concerns about the project, although they are small. These concerns arise primarily because the majority of the project would be constructed outside the city limits in areas not as prone to flooding as the city. Thus, some of the affected landowners would only receive minimal benefits from the proposed project. Although frequent communications have indicated that no homes would be affected, many landowners are concerned about the uncertainty

regarding their property and their lives and are waiting for the final feasibility report and public meetings to provide clarification. Owners of agricultural lands that would be purchased for the proposed project would be compensated at fair market value.

Real Estate

The Roseau flood damage reduction project has a number of features including the east diversion channel, high-flow storage areas, and recreation features. The current outline for the proposed project would affect approximately 30 landowners.

The total area to be acquired for the project is 1,855.7 acres of which 3.7 acres would be required for temporary work areas (temporary construction easements). With the exception of the 3.7 acres of temporary construction easements, the non-Federal sponsor would acquire all lands in fee simple title. The value of lands and damages for the acquisition of the required areas and easements is estimated at \$3,984,000. This figure includes lands owned by the non-Federal Sponsor and various right-of-way entities. The only structures that would be affected by the project are two, side-by-side machine shed buildings located in a portion of the project that would serve as an overflow area of the diversion channel.

During the 2002 flood, approximately 90 percent of the homes and businesses within the city of Roseau were severely damaged. The project, as it is proposed, would significantly reduce the amount of damage caused by a similar event. In an effort to gain full support, several initial public contact meetings have been held, along with a local landowner meeting in April 2005.

Some landowners within the project alignment are uncomfortable with the project in their backyard, but most landowners realize how important the proposed project is to the city's survival. With the addition of recreational features attributed to the overall project, the majority of landowners appear supportive of the project.

The following considerations were made when developing the project alignment:

1. The inlet to the diversion channel would cross through the Roseau City Park and Campground Area.
2. Efforts were made to avoid taking homesteads and to minimize social impacts. The project team will continue to be aware of social impacts in the plans and specifications phase and will minimize them when possible.
3. Efforts were made to avoid wetlands and minimize effects on wetlands. The project team will continue to avoid and minimize wetland effects when possible throughout the remainder of the project.

4. An additional bridge was added in response to public concern. Initially it was thought it would not be needed because alternative routes were available.
5. Recreational features were developed for multiple uses.

The city has been notified of the risks of purchasing property in advance of the PCA signing.

Effects of the Recommended Plan

On the basis of Corps evaluations and public, interagency, and non-Federal sponsor inputs provided to this plan formulation and environmental evaluation process, the overall social, economic, and natural impacts of the recommended plan would be positive. From the local and State perspective, the most important effect would be that hundreds of homes, businesses, and public structures would be protected from future floods and removed from the 100-year regulatory floodplain, and future flood damages would be reduced 85.7 percent. In addition to the many flood damage reduction benefits, the city would also receive benefits from the recreational features that are currently absent in the Roseau area. It is important to note that the economic analysis done as a part of this study claims national flood damage reduction and associated recreation benefits.

Public and landowner inputs identified some localized negative impacts on directly affected landowners and adjacent landowners as a result of the project construction and changes in land use. Such impacts have been carefully avoided to the extent possible in the alignments and designs now integrated into the recommended plan. Where project-related impacts could not be avoided, fair compensation to affected parties is fully accounted for in the baseline cost estimate.

The recommended project would provide many long-term local and regional economic benefits that are not incorporated into the economic benefits attributed to the recommended plan but are very real and important to the community and its residents. These benefits include improved community cohesion, preserved and improved property values and local tax base, improved aesthetics, improved public health and safety, and future enhanced community growth and development opportunities.

An environmental assessment has been prepared to fully assess the impacts of the recommended project and obtain public and interagency comments. This document is a part of this feasibility report. Public and interagency inputs will be requested and integrated, following the 30-day review period, as part of the environmental assessment process. Future additional refinements to the project design may result from detailed designs to be conducted as part of preparing plans and specification and these may somewhat alter project materials, design, cost, and cost apportionment or Federal participation in the project or any of its components. Any changes in project formulations that might affect environmental acceptability will be fully re-coordinated during the plans and specifications phase.

Future Remedial Actions

The recommended plan is not designed to protect against the largest river floods (it is calculated that the proposed project would protect against nearly 86 percent of possible future flood damages). The recommended NED plan would, however, place the city of Roseau in a more favorable position to fight the larger floods. Unlike levees, where a large overtopping event can be completely devastating, a diversion channel offers a unique opportunity to assist in those events of larger proportion, where additional flood fighting measures will need to be taken. As a result, it is desirable for the city to seek additional means to provide higher levels of safety from future floods.

This additional level of safety may be possible by pursuing basin-wide flood damage reduction solutions to reduce river stages. City, State, and Federal support for such actions should be pursued cooperatively. Potential upstream storage strategies that could provide an added level of flood stage long-range flood damage reduction could be explored.

Other strategies/measures that should be considered to further reduce the flood risk to Roseau include the following:

- Local, county, and township roads and future highways in the Roseau area should be designed as secondary lines of flood defense against potential future flooding. This measure is something local governments can control and implement. Over time, as the city continues to grow and replace or add to the existing infrastructure, this flood protection strategy should be incorporated.
- If new bridges are needed in the study area to serve a growing population and as existing bridges age, bridges should be designed to avoid obstruction of river flows. This measure could provide an increment of flood risk reduction. This strategy is a long-term effort to be implemented after a Federal flood damage reduction project is completed.
- Short-term flood damage reduction measures should also continue to be pursued. These plans are accomplished at the local level and will help minimize the potential for short-term flood damages - prior to completing a permanent flood damage reduction project. Existing emergency flood fighting plans should be kept up-to-date, and national flood insurance should be purchased to help reduce individual impacts resulting from floods.
- Long-term flood damage reduction measures should also be pursued for those larger floods. Upstream storage of floodwaters could be a very important future addition to reducing flood risks for local farmers and for the study area. The recommended local flood protection plan recommended in this report fits well with such regional flood measures.

- The city should be prepared to fight larger events and should continue to train volunteers and other public agencies, as is currently done, to be prepared for the next “big one.” Being prepared for future events is one of the best ways to protect the city in the rare event that the designed Federal project is overwhelmed.
-

Conclusions

The 2002 flood demonstrated forcefully the need for a localized permanent flood damage reduction project to protect Roseau. The temporary levee systems are not continuous and do not provide any certifiable level of protection. Without a Federal flood damage reduction project, most of the community will continue to be located in the 100-year regulatory floodplain. This has many implications for the community and makes development of a permanent flood damage reduction project more compelling.

The recommended plan has been designed and optimized to provide a 100-year level of protection (1.0-percent exceedance frequency flood event). This substantial and reliable flood protection for Roseau is important to implement from a local, State, and Federal perspective. Because the recommended Federal plan would not provide reliable protection against very large floods, further local initiatives to pursue flood fighting and added regional upstream storage actions to further reduce flood risk for the study area are needed.

The recommended plan would also provide for implementation of recreational features that would expand on the area’s existing recreational and environmental opportunities. This multifeatured recommended plan is feasible economically (i.e., detailed economic and cost evaluations result in significant net benefits, and the plan has an overall benefit-cost ratio of 2.89).

On the basis of public, interagency, and non-Federal sponsor inputs to this plan formulation and environmental evaluation process, it is clear that the overall social, economic, and natural effects of the recommended plan would be positive.

Further plan refinements will be conducted throughout detailed designs to be accomplished during the plans and specifications phase to reduce project costs and minimize project related impacts. These refinements may alter project materials, design, cost, and cost apportionment or Federal participation in the project or any of its components.

Recommendation

As District Engineer, I have considered the environmental, social, and economic effects; the engineering feasibility; and comments received from the other resource agencies, the non-Federal sponsor, and the public and have determined that the recommended plan presented in this report is in the overall public interest and is technically sound, environmentally acceptable, and economically feasible.

The recommended plan is the Locally Preferred Plan (LPP) and includes flood damage reduction features consisting of a 4.5-mile diversion canal, 5.1 miles of diversion channel levees, 4.1 miles of levees to store floodwaters, and other appurtenant facilities and primary recreation features consisting of multipurpose trails, restrooms, potable water, picnic facilities, parking areas, and landscaping and tree plantings. The total estimated first costs of the recommended plan based on October 2005 price levels is \$24,417,000, with the Federal and non-Federal shares of total first costs estimated at \$13,384,600 and \$11,032,400, respectively. The flood damage reduction features have an estimated total first cost of \$22,756,000, with the Federal and non-Federal shares estimated at \$12,554,100 and \$10,201,900, respectively. The recreation features have an estimated total first cost of \$1,661,000, with the Federal and non-Federal shares estimated at \$830,500 and \$830,500, respectively. The annual operation and maintenance costs are \$67,826. The recommended plan has an overall benefit-cost ratio of 2.89 and would provide a 100-year level of protection for the majority of the city.

These recommendations are made with the provision that, prior to implementation, the non-Federal sponsor will agree to comply with the following requirements:

1. Provide a minimum of 35 percent, but not to exceed 50 percent, of total NED plan project costs allocated to structural flood damage reduction and 50 percent of total project costs
 - a. Prior to execution of the project cooperation agreement for the project, enter into an agreement to pay 25 percent of design costs.
 - b. Provide during the first year of construction any additional funds necessary to pay the full non-Federal share of the design costs allocated by the Government to the flood damage reduction and recreation features, respectively.
 - c. Provide, during construction, a cash contribution equal to 5 percent of total project costs assigned to structural flood damage reduction.
 - d. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance

of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project.

e. Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins that may be required at any dredged or excavated material disposal areas required for construction, operation, and maintenance of the project.

f. Provide, during construction, any additional costs as necessary to make the total non-Federal contributions equal to 35 percent of total NED plan project costs allocated to the structural flood damage reduction features and 50 percent of total project costs allocated to the recreation features.

g. Provide all incremental costs for the LPP.

2. Provide the non-Federal share of that portion of total cultural resource preservation mitigation and data recovery costs attributable to structural flood damage reduction and to recreation that are in excess of 1 percent of the total amount authorized to be appropriated to the project, in accordance with the cost sharing provisions of the project cooperation agreement.

3. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

4. Grant the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of inspection and, if necessary, for the purpose of completing, operating, maintaining, repairing, rehabilitating, or replacing the project.

5. Comply with Section 221 of Public Law 91-661, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence construction of any water resources project or separable element thereof until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

6. Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

7. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

8. Perform, or cause to be performed, any investigations for hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

9. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

10. Agree that, as between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

11. Participate in and comply with applicable Federal floodplain management and flood insurance programs.

12. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within 1 year after the date of signing the PCA, and to implement such plan not later than 1 year after completion of construction of the flood damage reduction features. The plan shall be designed to reduce the impacts of future flood events in the project area, including but not limited to, addressing those measures to be undertaken by non-Federal interests to preserve the level of flood protection provided by the flood damage reduction features of the project. The non-Federal sponsor shall provide an information copy of the plan to the Government upon its preparation.

13. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities that might reduce the level of protection the flood damage reduction features of the project afford, hinder operation and maintenance of the project, or interfere with the project's proper function. In particular, requiring permits to modify roads or other obstacles that would affect overland flows with proposed changes modeled and allowed by permit only if they do not interfere with the proper functioning of the project.

14. Not less than once each year the non-Federal sponsor shall inform affected interests of the extent of protection afforded by the flood damage reduction features of the project.

15. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

16. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 C.F.R., Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those required for relocations, the borrowing of material, or the disposal of dredged or excavated material, and shall inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

17. Provide and maintain access roads, parking areas, and other associated public use facilities, and ensure such facilities are open and available to all on equal terms.

18. Comply with all applicable Federal and State laws and regulations, including, but not limited to the following: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).

19. Be solely responsible for all costs for project betterments and pay all such costs. The non-Federal sponsor may request the Government to accomplish such betterments in writing. If the Government elects to accomplish the requested betterments or any portion thereof, it shall so notify the non-Federal sponsor in writing and perform such betterments in accordance with the provisions of the project cooperation agreement.

20. Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified

before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the non-Federal sponsor, the State of Minnesota, interested Federal agencies, and other parties will be advised of any modifications and will be afforded the opportunity to comment further.

Michael F. Pfenning
Colonel, Corps of Engineers
District Engineer

PLAN PLATES

(NOTE: See Plate Title Block for description)

TECHNICAL APPENDIXES

A – L

TECHNICAL APPENDICES APPENDIXES A – L

DETAILED TECHNICAL DOCUMENTATIONS ARE INCLUDED AS PART OF THIS FEASIBILITY STUDY REPORT. HOWEVER, NOT ALL SUPPORTING DOCUMENTATION HAS BEEN INCLUDED IN THIS REPORT. IF SPECIFIC ADDITIONAL TECHNICAL BACKGROUND OR EVALUATION DATA PERTINENT TO THIS PROJECT IS DESIRED, THIS INFORMATION MAY BE AVAILABLE UPON REQUEST.

Appendix A	Hydrologic & Hydraulic Existing Conditions Appendix
Appendix B	Hydraulics Design Appendix
Appendix C	Economics – Social – Financial Appendices
Appendix D	Cost Engineering Appendix
Appendix E	Environmental Assessment
Appendix F	Real Estate Supplement/Appendix
Appendix G	Geotechnical Appendix
Appendix H	Structural Design Appendix
Appendix I	Recreation and Aesthetics Appendix
Appendix J	Public Involvement and Review Comments

Appendix A

Hydrologic & Hydraulic Existing Conditions

Appendix B

Hydraulic Design

Appendix C

Economics – Social – Financial

Appendix D

Cost Engineering

Appendix E

ENVIRONMENTAL ASSESSMENT

Appendix F

Real Estate Supplement

Appendix G

Geotechnical

Appendix H

Structural Design

Appendix I

Recreation & Aesthetics

Appendix J

Public Involvement and Review Comments